MOTIVATING HEALTHY DRINKING BEHAVIORS AMONG CHILDREN

THE EFFECTS OF THE SHARE H_2O SOCIAL NETWORK INTERVENTION

Behavioural Science Institute

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MOTIVATING HEALTHY DRINKING BEHAVIORS AMONG CHILDREN:

The Effects of the *Share H_2O* Social Network Intervention

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ISBN: 978-94-6416-657-6

Cover design: Bo Polman & Publiss

Layout: Publiss | www.publiss.nl

Printing: Ridderprint | www.ridderprint.nl

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Proefschrift

ter verkrijging van de graad van doctor

aan de Radboud Universiteit Nijmegen

op gezag van de rector magnificus prof. dr. J.H.J.M. van Krieken,

volgens besluit van het college van decanen

in het openbaar te verdedigen op

donderdag 23 september 2021

om 10.30 uur precies

door

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geboren op 8 december 1988

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Doctoral Thesis

to obtain the degree of doctor

from Radboud University Nijmegen

on the authority of the Rector Magnificus prof. dr. J.H.J.M. van Krieken,

according to the decision of the Council of Deans

to be defended in public on

Thursday, September 23, 2021

at 10.30 hours

by

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Voor PAPA

dit is het moment waar je met grote trots naar uitkeek

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GENERAL INTRODUCTION

BACKGROUND

The rising rate of childhood overweight and obesity has been a major public health concern for over the past three decades (WHO, 2020). Recent estimates suggest that in 2016 over 340 million children and adolescents between the ages of 5 and 19 years were overweight or obese worldwide (WHO, 2020). In the Netherlands specifically, 13.9% of the children and adolescents between the ages of 4 and 20 years were overweight in 2019, with 2.2% being obese (CBS, 2020a). This corresponds to 1 in 7 Dutch children being overweight or obese. Overweight and obese children have a higher risk of obesity later in life, disability in adulthood, an increased risk of developing cardiovascular diseases and insulin resistance at a younger age, and premature death (WHO, 2020). Overweight and obesity, as well as its health consequences, are largely preventable and therefore their prevention remains a high priority for public health (WHO, 2020).

There is an extensive body of research indicating that the consumption of sugar-sweetened beverages (SSBs; such as soda, sweetened juice drinks, and energy drinks) is positively associated with overweight and obesity in children (e.g., Garduño-Alanís et al., 2020; Luger et al., 2017; Marshall, Curtis, Cavanaugh, Warren, & Levy, 2019). The calories from SSBs have little nutritional value and do not lead to a sense of satiety; therefore, SSBs are assumed to cause an increase in total energy intake and ultimately in weight gain (Mattes, 2006). Research has shown that consuming at least one SSB per day can lead to an additional weight gain of 6.75kg in one year (Apovian, 2004). Although the consumption of SSBs has started to decline in recent years; children still consume more than the recommended amount of SSBs (Marriott, Hunt, Malek, & Newman, 2019). On any given day, about half of the children (54%) consume at least one SSB with an estimated daily contribution of 94 kilocalories. The consumption of SSBs is currently one of the largest single caloric food source of children's energy intake (Marriott et al., 2019).

As a result, there is an increasing focus among policymakers to reduce the consumption of SSBs among children to prevent and reduce overweight and obesity at a young age (Muth et al., 2019). Encouraging healthier alternatives,

such as water—which contains no calories and also reduces cravings—has been found to be a promising approach (Zheng, Allman-Farinelli, Heitmann, & Rangan, 2015). Several longitudinal studies have shown that replacing SSBs with water can have a beneficial effect on body weight in children (Avery, Bostock, & McCullough, 2015; Zheng, Allman-Farinelli, et al., 2015; Zheng, Rangan, et al., 2015). However, the water intake of children aged 9 to 13 years has been relatively low for years (Drewnowski, Rehm, & Constant, 2013; Piernas, Barquera, & Popkin, 2014; Vieux, Maillot, Constant, & Drewnowski, 2016, 2017; Vieux, Maillot, Rehm, Barrios, & Drewnowski, 2020), below the recommended level of 2000 ml/day total water intake (i.e., including water from drinking water, beverages of all kind, and food moisture; EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA), 2010). A recent study of water consumption patterns among children aged 9 to 13 years showed that their total dietary water intake was 1691 ml/day, from which only 577 ml/day came from drinking plain water (Vieux et al., 2020). It is therefore essential that interventions focus on encouraging and promoting water intake in children.

Mass media interventions are widely used in the public health sector to address a variety of health behaviors (Wakefield, Loken, & Hornik, 2010), including the consumption of water and SSBs (e.g., Bleakley, Jordan, Mallya, Hennessy, & Piotrowski, 2018; Caldwell et al., 2020; Farley et al., 2017; Kite et al., 2018; Morley et al., 2019). Such mass interventions use standardized media messages to change the knowledge, attitudes, intentions, and behavior of multiple individuals simultaneously in a relatively inexpensive way (Wakefield et al., 2010). Unfortunately, they have a limited effect on actual health behavior change (Anker, Feeley, McCracken, & Lagoe, 2016). A possible explanation may be that these interventions do not take into account the (social) environment of the targeted individuals (Sharma, 2006). Findings from a meta-analysis suggest that water promotion interventions targeting changes in the (social) environment may have a greater impact on behavior (Franse et al., 2020). Therefore, there is a strong need to investigate interventions strategies targeting changes at the environmental level. A possible avenue might lie in incorporating the role of the social context and peer influences in interventions.

Peers Norms and Dietary-Related Behaviors

Drinking and eating are social activities and often take place in the presence of parents, siblings, and/or peers. There is ample evidence that the norms, values, and assumptions embedded in the social context exerts a strong influence on what, and how much individuals drink and eat (Higgs, 2015; Higgs & Ruddock, 2020; Salvy, de la Haye, Bowker, & Hermans, 2012). Especially in children, the social environment is an important factor in the initiation and maintenance of eating patterns (Patrick & Nicklas, 2005). Parents and peers are the primary social influences that contribute to the dietary-related behaviors of children (Williams, Holmbeck, & Greenley, 2002). Peers are especially important role models when children mature and spend most of their waking hours in the company of peers, for example at school (Rubin, Bukowski, & Parker, 2007). There is a large body of evidence to suggest that peers have a strong influence on children's food intake and choices (Cruwys, Bevelander, & Hermans, 2015; Herman, 2015; Higgs & Ruddock, 2020; Salvy & Bowker, 2013; Salvy et al., 2012; Vartanian, 2015).

One reason why other individuals have a powerful influence on children's food intake and choice is the operation of social norms. Social norms in the context of food intake involve social cues about what constitutes appropriate consumption, whether it is the amount of food or specific food choices, for individuals in a social group (Higgs, 2015). Previous research has shown that dietary-related behaviors are associated with the perceived social norms within peer groups (Higgs, 2015; Robinson, Blissett, & Higgs, 2013; Robinson, Thomas, Aveyard, & Higgs, 2014; Stok, Vet, Ridder, & Wit, 2016). In the literature, a distinction is made between two types of social norms: descriptive and injunctive norms (Cialdini, Kallgren, & Reno, 1991; Reno, Cialdini, & Kallgren, 1993). Descriptive norms refer to the perceptions of how people actually behave in a social group (Cialdini et al., 1991). For example, a descriptive norm related to water drinking might be that children perceive that most of their peers drink more or less than the recommended amount of water. A mechanism that could explain how descriptive norms influence children's healthy drinking behavior, is social modeling. This is the tendency of individuals

to directly adjust their dietary-related behavior to that of others (Cruwys et al., 2015; Vartanian, Spanos, Herman, & Polivy, 2015). Research on social modeling in children has consistently shown that children tend to adapt their own food choices and intake to those of their table companions. That is, children eat or drink more or less when their peers also eat or drink more or less food (Cruwys et al., 2015; Salvy, Coelho, Kieffer, & Epstein, 2007; Salvy, Romero, Paluch, & Epstein, 2007).

Injunctive norms refer to the perceptions of what behavior is expected by others in the social group (Cialdini et al., 1991). For example, an injunctive norm related to water drinking might be that children think their peers expect them to drink a certain amount of water. Two mechanisms that could explain how injunctive norms influence children's healthy drinking behavior are impression management and social facilitation. Impression management is the tendency for children to adjust what and how much they eat or drink in order to convey a good impression of themselves to others (Leary & Kowalski, 1990; Vartanian, 2015). Research has found that children consume less in the presence of other peers compared to when they are alone (Salvy, Coelho, et al., 2007; Salvy, Romero, et al., 2007) and that their weight status plays a role when eating with a normal-weight eating companion (Bevelander, Anschütz, & Engels, 2012). Conveying a good impression by suppressing food intake may be due to the fact that consuming large amounts of food is associated with obesity (Vartanian, Herman, & Polivy, 2007). Social facilitation refers to an increase in food intake due to the mere presence of others (Herman, 2015; Zajonc, 1965). This increased food intake is believed to be proportional to the number of individuals (de Castro & Brewer, 1992). Research has consistently found that children consumed more food in larger groups than in smaller groups (de Castro, 1994; Lumeng & Hillman, 2007).

All together, these interrelated mechanisms indicate that observing and interacting with peers can influence children's behaviors with regard to food intake and choice (Salvy & Bowker, 2013; Salvy et al., 2012). Despite this important role of peers, they are relatively overlooked when developing interventions aimed at preventing childhood obesity. The involvement of children's peer networks in interventions

is suggested to be critical for the promotion of positive dietary-related behaviors (Salvy et al., 2012). Therefore, the present dissertation explored the potential of using peer influence in interventions, taking into account the role of social norms.

Social Network Interventions

A state-of-the-art intervention approach that utilizes peer influence in order to promote behavioral change, is the *social network intervention* (Valente, 2012, 2015). At the heart of this approach lies diffusion of innovations theory, which conceptualizes how new ideas, beliefs, and behaviors are informally diffused through individuals in a social network (Rogers, 2010). During the diffusion process, some individuals lead in influencing their peers' opinion and beliefs and serve as social models due to their unique and influential position in the social network (Rogers, 2010). These individuals can be deployed to initiate and accelerate the diffusion process of the target behavior in their social networks (Valente & Davis, 1999).

Based on this premise, in social network interventions a subset of individuals are selected and trained as *influence agents* (also referred to in the literature as *opinion leaders*, *peer supporters, peer leaders* or *champions*; Campbell et al., 2008; Valente & Pumpuang, 2007) to informally diffuse the intended message or behavior in their social network (Valente, 2012). The literature describes several methods of selecting influence agents (e.g., celebrities, self-selection, expert identification, or peer nominations), with the most commonly used method being peer nominations of all members in their social network. Those who have received the most nominations (i.e. the top 10 to 15%) are then selected as influence agents (Valente, 2012; Valente & Pumpuang, 2008).

This social network intervention approach has already been applied in the field of public health (Bell, Audrey, Cooper, Noble, & Campbell, 2017; Campbell et al., 2008; Kelly et al., 1991; Sebire et al., 2018; Story, Lytle, Birnbaum, & Perry, 2002; Valente, Hoffman, Ritt-Olson, Lichtman, & Johnson, 2003; Valente et al., 2003; van Woudenberg et al., 2018). An example of particular relevance to the objectives

of this dissertation is the ASSIST intervention (A Stop Smoking In Schools Trial), one of the best known and large-scale social network interventions (Campbell et al., 2008). In the ASSIST intervention, young adolescents nominated classmates based on five sociometric nomination questions (e.g., "Who are good leaders in sports and other group activities at your school?" and "Who do you look up to in Year 8 at your school?"). Those who received the most nominations were trained as influence agents to have informal conversations with their peers to encourage them to not to smoke during 10 intervention weeks (Starkey, Audrey, Holliday, Moore, & Campbell, 2009). The ASSIST social network intervention was effective in reducing the prevalence of smoking up to two years after the start of the intervention (Campbell et al., 2008).

Until the start of this PhD project, the social network approach had not been adopted to address healthy drinking behaviors in children. Given the important role of peer influence mechanisms, especially when it comes to healthy drinking behaviors, this dissertation followed the social network approach (Valente, 2012) to develop the so-called *Share* H_2O intervention. In this social network intervention, influence agents were trained to informally diffuse messages about water consumption— as an alternative for SSBs—among their peers. To do so, we incorporated a novel, theory-based approach to motivate the influence agents.

Integrating Self-Determination Theory in Social Network Interventions

The social network intervention literature mainly focuses on the process of selecting the most successful influence agents to diffuse the message and behavior. Specifically, the focus is on investigating the most effective sociometric nomination questions and selection criteria to identify the influence agents (Ott, Light, Clark, & Barnett, 2018; Starkey et al., 2009; Valente, 2012; Valente & Pumpuang, 2008; Woudenberg et al., 2019). As yet, there is hardly any attention in the literature on how to exactly to get the influence agents to diffuse the message and behavior. In other words, how to optimally motivate the influence agents to perform and promote the intended health-related behavior among their peers.

In recent years, self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2017), a prominent theory of human motivation, has emerged as a promising theoretical framework for interventions in health promotion (Gillison, Rouse, Standage, Sebire, & Ryan, 2019; Ng et al., 2012; Ryan, Patrick, Deci, & Williams, 2008; Teixeira et al., 2020). Self-determination theory focuses on the understanding of the social contextual factors that facilitate or undermine human motivation (Ryan & Deci, 2017). Research based on self-determination theory has amply demonstrated that intrinsic motivation, the most autonomous kind of motivation, is an essential determinant for adopting and maintaining health behavioral change (Hagger et al., 2014). Intrinsic motivation refers to the inner drive to perform a behavior, because it is inherently interesting or enjoyable (Ryan & Deci, 2000, 2017). Intrinsically motivated individuals tend to adopt and maintain healthy lifestyle patterns over the long term, such as eating healthier, consuming fruits and vegetables, and exercising (Mata et al., 2009; Pelletier, Dion, Slovinec-D'Angelo, & Reid, 2004; Silva et al., 2011; Teixeira et al., 2015).

According to self-determination theory, being intrinsically motivated depends on whether the social context satisfies individuals' three basic psychological needs: autonomy (feeling that one has ownership and choice), competence (feeling that one is capable and effective), and relatedness (feeling connected and caring for others; Deci & Ryan, 2000; Ryan & Deci, 2017). These psychological needs can be satisfied in an autonomy-supportive context which entails that meaningful rationales are provided, individuals' perspectives are acknowledged, choices are offered, and initiatives are supported, while minimizing pressure and control (Deci & Ryan, 2000; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Therefore, we used the principles of self-determination theory to guide the design and delivery of the *Share* H_2O social network intervention. Specifically, in the training of the influence agents we aimed to create an autonomy-supportive context that intrinsically motivated them, and via them, their peers, to perform the behavior.

THIS DISSERTATION

The general objective of this dissertation was to investigate the effects of the *Share H_2O* social network intervention to motivate healthy drinking behaviors in influence agents and their peers. We approached this general objective with four specific research aims. The first aim was to investigate whether a social network intervention grounded in self-determination theory improves children's consumption behaviors. In a proof-of-principle study, we tested the effectiveness of the *Share H_2O* social network intervention, in which influence agents were trained to encourage water consumption—as an alternative for SSBs—among their peers. The second aim was to explore how the intervention could be improved by gaining more insight into the role of intrinsic motivation in predicting healthy drinking behaviors compared to other dominant theoretical predictors. The third aim was to compare the effectiveness of the improved *Share H_2O* social network intervention to a mass media intervention—which is widely used in the public health sector—and no intervention. Finally, our fourth aim was to acquire an in-depth understanding of the underlying processes of motivating the influence agents, and via them, their peers, to adopt healthy drinking behaviors. All studies were embedded in the *MyMovez* research program.

The *MyMovez* Research Program

The *Share H_2O* social network intervention was part of the *MyMovez* research program, a large-scale five-year research project funded by of the European Research Council that aimed to develop and test methods for effective social network health campaign implementation (see Bevelander et al., 2018). In this program, participants received the *Wearable Lab*: a smartphone with a pre-installed research application and a wrist-worn accelerometer. Through the *MyMovez* research application, participants received daily questionnaires (e.g., dietary-related questions or sociometric questions) and were able to use a social media platform (*Social Buzz*), create a personalized avatar, and play a puzzle game (Zoko). In the *Social Buzz* participants could chat, *share* pictures and short videos with their peers, and also contact the researchers (Bevelander et al., 2018). In the *Share H_2O*

social network intervention, the *Wearable Lab* was used as a measurement tool for children's behavior and as a social media platform for the influence agents to promote the behavior.

Outline of This Dissertation

The four research aims of this dissertation were addressed in separate empirical studies, which are described in the following four chapters (Chapters 2-5). The content of these empirical chapters is similar to articles that have been published in scientific journals. The four empirical chapters are briefly introduced below, including their research aims. The final chapter (Chapter 6) discusses the main findings and limitations of the dissertation and provides recommendations for both future research and practice.

Chapter 2—A social network-based intervention stimulating peer influence on children's self-reported water consumption: A randomized control trial

The aim of the proof-of-principle study described in Chapter 2 was to investigate whether a social network intervention grounded in the self-determination theory could be a promising approach to positively alter children's consumption behaviors. The study consisted of a randomized controlled trial that tested the effectiveness of the *Share* H_2O social network intervention on children's water consumption, sugar-sweetened beverage consumption, and intentions to drink more water. In the study, children (N = 210; 52% girls; M_{age} = 10.75, SD_{age} = .80) were randomly assigned to either the *Share* H_2O social network intervention or no intervention. In the *Share* H_2O social network intervention, we followed the ASSIST approach for the selection of the influence agents. Subsequently, the influence agents were trained, based on self-determination theory principles, to motivate water consumption—as an alternative for SSBs—within their peer networks for eight weeks. The findings showed potential for a self-determination theory-based social network intervention, in that the intervention increased the children's water consumption and decreased their SSB consumption. The corresponding article to this chapter was published in *Appetite* (Smit, de Leeuw, Bevelander, Burk, & Buijzen, 2016).

Chapter 3—An integrated model of fruit, vegetable, and water intake in young adolescents

The aim of the longitudinal study described in Chapter 3 was to examine the role of intrinsic motivation in predicting healthy drinking behaviors compared to other dominant theoretical predictors. The study consisted of an integrated model that investigated various theoretical perspectives to determine which mechanism is the most predictive of changes in children's fruit, vegetables and water consumption over time. The model was based on evidence from health research applying predictors from various theoretical perspectives, including the theory of planned behavior (i.e., self-efficacy, attitude, norms, and behavioral intentions), social norms (i.e., injunctive and descriptive norms) and the self-determination theory (i.e., intrinsic motivation). The study used four data-collection waves from the *MyMovez* research program that included both children and young adolescents (N = 953; 53.9% girls; M_{age} = 11.19, SD_{age} = 1.36). The corresponding article to this chapter was published in *Health Psychology* (Smit et al., 2018).

Chapter 4—Promoting water consumption among children: A three-arm cluster randomized controlled trial testing a social network intervention

The aim of the study described in Chapter 4 was to compare the effectiveness of the *Share* H_2O social network intervention to a mass media intervention and no intervention. The study consisted of a three-arm cluster randomized controlled trial that tested the effectiveness of the improved *Share* H_2O social network intervention on children's water and SSB consumption. Children (N = 451; 50.8% girls; M_{age} = 10.74, SD_{age} = .97) were randomly assigned to either the *Share* H_2O social network intervention, active control condition or no intervention. The approach and content of the *Share* H_2O social network intervention was nearly the same as in the proof-of-principle study (Smit et al., 2016); however, we attempted to improve the content of the training by incorporating more principles of the self-determination theory. The active control condition was based on the principle of mass media interventions, exposing all children simultaneously to the benefits of

drinking water. The corresponding article to this chapter was published in *Public Health Nutrition* (Smit et al., 2020).

Chapter 5—Promoting water consumption among Dutch children: An evaluation of the social network intervention *Share H_2O*

The aim of the study described in Chapter 5 was to evaluate the process of motivating the influence agents, and via them, their peers, to develop healthy drinking behaviors. This chapter describes a study that evaluates the process of implementing the *Share H_2O* social network intervention, in (1) motivating influence agents to drink more water themselves and (2) supporting them in motivating their peers to drink more water. The evaluation was based on the theoretical framework of the self-determination theory which guided the design of the *Share H_2O* training. To evaluate the implementation of the *Share H_2O* social network intervention, reports from both the influence agents (N = 37; 48.6% girls; M_{age} = 10.95, SD_{age} = .94) and the peers (N = 112; 47.3% girls; M_{age} = 10.84, SD_{age} = 1.04) in the networks of the influence agents were used. The corresponding article to this chapter was published in *BMC Public Health* (Smit et al., 2021).

2

SOCIAL NETWORK-BASED INTERVENTION STIMULATING PEER INFLUENCE ON CHILDREN'S SELF-REPORTED WATER CONSUMPTION: A RANDOMIZED CONTROL TRIAL

This chapter is published as:
Smit, C. R., de Leeuw, R. N., Bevelander, K. E., Burk, W. J., & Buijzen, M. (2016).A social network-based intervention stimulating peer influence on children's self-reported water consumption: A randomized control trial. *Appetite, 103,* 294-301.
https://doi.org/10.1016/j.appet.2016.04.011

ABSTRACT

The current pilot study examined the effectiveness of a social network-based intervention using peer influence on self-reported water consumption. A total of 210 children (52% girls; M_{age} = 10.75, SD_{age} = .80) were randomly assigned to either the intervention (n = 106; 52% girls) or control condition (n = 104; 52% girls). In the intervention condition, the most influential children in each classroom were trained to promote water consumption among their peers for eight weeks. The schools in the control condition did not receive any intervention. Water consumption, sugar-sweetened beverage consumption, and intentions to drink more water in the near future were assessed by self-report measures before and immediately after the intervention. A repeated measure MANCOVA showed a significant multivariate interaction effect between condition and time (V = .07, F(3, 204) = 5.18, p = .002, $p\eta^2$ = .07) on the dependent variables. Further examination revealed significant univariate interaction effects between condition and time on water (p = .021) and sugar-sweetened beverage consumption (p = .015) as well as water drinking intentions (p = .049). Posthoc analyses showed that children in the intervention condition reported a significant increase in their water consumption (p = .018) and a decrease in their sugar-sweetened beverage consumption ($p < .001$) over time, compared to the control condition (p-values > .05). The children who were exposed to the intervention did not report a change in their water drinking intentions over time (p = .576) whereas the nonexposed children decreased their intentions (p = .026). These findings show promise for a social network-based intervention using peer influence to positively alter consumption behaviors.

BACKGROUND

Childhood obesity is among the most serious public health problems in the 21st century (WHO, 2020). At present, 11% of European (CBS, 2012) and 17% of American children (Ogden, Carroll, Kit, & Flegal, 2012) are estimated to be overweight or obese. Beyond the increased risk of becoming obese as an adult, overweight children have a higher risk of developing physical problems such as diabetes and cardiovascular diseases (WHO, 2015). The consumption of sugar-sweetened beverages (SSBs) has been identified as a major contributor to the obesity epidemic (Hu, 2013). Approximately 66% of children consume at least one SSB per day (Han & Powell, 2013), which can lead to an additional weight gain of 6.75 kg in one year (Apovian, 2004).

Research suggested that reducing SSB consumption may be an effective way to prevent children from becoming overweight or obese (Hu, 2013). Specifically, targeting SSB consumption by means of promoting water consumption—which has zero calories and can reduce cravings for SSBs—seems to be a promising approach (Hu, 2013). Unfortunately, several interventions that tried to stimulate water consumption have shown limited effects on changing children's behavior (e.g., Loughridge & Barratt, 2005; Muckelbauer et al., 2009; Visscher et al., 2010). A possible explanation is that most health interventions focused on prevention strategies on an individual level (Sharma, 2006), even though the social environment has been found to have a strong influence on people's eating and drinking behavior (Cruwys et al., 2015; Emmons, Barbeau, Gutheil, Stryker, & Stoddard, 2007; Salvy et al., 2012). Especially among adolescents, social influence is an important factor in the initiation and maintenance of consumption behaviors (Patrick & Nicklas, 2005). Ample empirical studies have shown that children and adolescents adjust their intake to that of their table companions (Cruwys et al., 2015; Herman, Roth, & Polivy, 2003; Higgs, 2015). In children, social modeling studies have shown that peers can set a guideline or social norm in food choice and intake which is followed by others (see for review; Cruwys et al., 2015). Most of the social modelling studies have suggested implementing this knowledge into community or social network

intervention approaches (Cruwys et al., 2015). In addition, there is a need for intervention research taking into account the social status of the peers, given that the modeling effect may be stronger for role models who have a specific status in class (Teunissen et al., 2012). Therefore, the present study aims to promote water drinking by incorporating the social modeling mechanism in conjunction with peer status among children.

A theory that integrates both social influence and social network status is Roger's diffusion of innovation theory. It explains how members of a social network model the behavior and ideas of others (Rogers, 1962, 2010). High status peers or *influence agents* are individuals who have the most influence during the diffusion process due to their unique position in their social network, such as having a higher social status and more influence as a change agent (Rogers, 2010). Moreover, the ones who serve as role models in their social network are often most popular, well-liked, and trusted by others (Kelly, 2004; Valente & Pumpuang, 2008). The use of influence agents has already been applied successfully in the field of public health aimed at preventing HIV (Kelly et al., 1991) and decreasing tobacco use (Campbell et al., 2008; Valente et al., 2003). In these interventions, the most influential peers were identified and trained to spread and sustain new norms of behavior within their social networks.

In the current pilot study, we also followed this social network approach and trained the influential peers to promote water consumption within their social networks. Children do not drink enough water and apparently this beverage is considered unpopular among this age group (Drewnowski et al., 2013). Therefore, the training of the influence agents itself was developed based on insights from two important social influence theories: self-determination theory (Deci & Ryan, 1985) and self-persuasion theory (Aronson, 1999). According to the self-determination theory, supporting individuals' need for autonomy, relatedness, and competence (e.g., by providing choices) leads to autonomous internalization of behaviors that were initially of extrinsic origin (Deci & Ryan, 1985; Soenens & Vansteenkiste, 2010). Based on this, the training was designed to support the autonomy of the influence

agents in order to optimally motivate them to promote water consumption within their social networks. In the training, the influence agents were asked whether they actually would like to take on this role and, if so, providing them with the opportunity to determine for themselves how they would encourage their peers to drink more water. Research has shown that an autonomy supportive smoking cessation intervention focusing on choice increased adolescents' autonomous motivation to not smoke (Williams, Cox, Kouides, & Deci, 1999). Similarly, self-persuasion is an effective manner to sustain behavior change because it increases people's intrinsic motivation to change (Mussweiler & Neumann, 2000) by placing them in situations where they are motivated to persuade themselves in order to change their own attitudes or behavior (Aronson, 1999). In line with this, the training persuades the influence agents to consume more water themselves when asking them to argue in favor of water ("Write down arguments about how you could consume more water yourself"; Miller & Wozniak, 2001).

The present pilot study was the first to test a social network-based intervention using peer influence on children's self-reported water drinking behaviors. The aim of this study was to examine whether the *Share H_2O* intervention could effectively promote water drinking among primary schoolchildren. We hypothesized that children who were exposed to the social network-based intervention would report an increase in their water consumption (H1), a decrease in their SSB consumption (H2) and have stronger intentions to drink water (H3) over time compared to those who were not exposed to the intervention.

METHOD

Design

The study was a randomized control trial with schools as the unit of randomization. The schools were assigned randomly to either the *Share H_2O* intervention (social network-based intervention) or the control condition (no intervention) by an independent researcher. The *Share H_2O* intervention consisted of exposing the children to influence agents from their own classroom. Children in the control

condition did not receive any intervention. All children completed the same pre-intervention and post-intervention measures.

Power calculations were conducted using the program G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). To detect a small to medium effect (Valente et al., 2003) using a MANCOVA: repeated measures within-between interaction (f = .20) with two groups and two measurements, 199 participants were needed (power = .80, p = .05). In order to take attrition into account, a larger number of students were recruited.

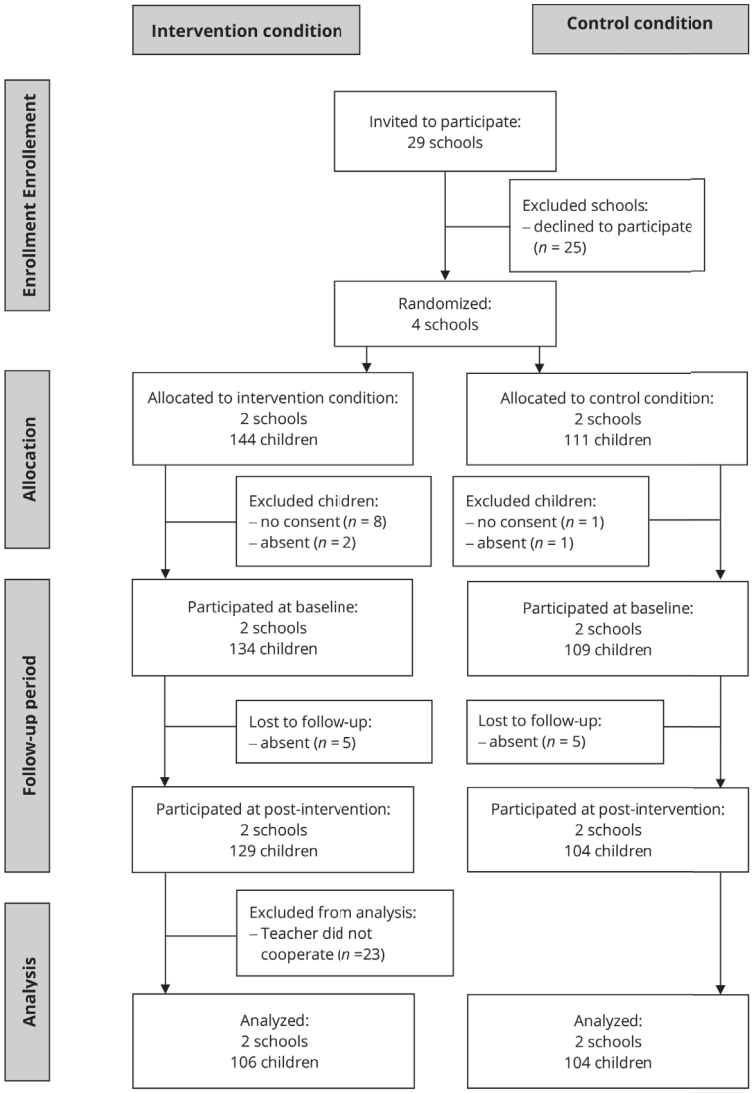
Participants

The participants were recruited through their primary schools. Twenty-nine urban and suburban primary schools in the Netherlands were invited to participate. Schools were eligible for participation if they were not involved in any water stimulation program. Ten schools expressed interest in participating; however, six of these were unable to participate due to difficulties scheduling the study. All schools participating in the study included more than 95% of children with a Dutch or West-European background. After gaining active consent from the headmasters of the schools, passive consent was obtained from the children's caretakers (i.e., the caretakers were informed about the study and could withdraw their child from participating). Out of 255 children, 9 (4%) caretakers withdrew their child from the study. At the outset of the study, we obtained informed consent from children. All children who were present at the baseline measurement (N =243) agreed to participate.

As shown in Figure 2.1, the schools allocated to the intervention condition included 144 children versus 111 children in the control schools. Of these, 243 (95%) children provided baseline data (n = 134 intervention, n = 109 control). Five children (4%) in the intervention schools and five (5%) in the control schools did not complete the post-intervention questionnaire. The reason for attrition was children being absent from school on the day of testing. In addition, an entire class (n = 23) in the intervention condition was excluded from the analysis, because the teacher undermined the study and discouraged the children to participate

seriously. Thus, the final sample consisted of 210 children (52% girls) between 9 and 13 years old (*M* = 10.75 years, *SD* = .80). Of these children, 104 (52% girls) were in the control condition and 106 children (52% girls) in the intervention condition. A total of 25 children from the five intervention classes were trained as influence agents. This resulted in a mean of 5 influence agents (*SD* = 1.41) per class.

Figure 2.1 CONSORT flow diagram of participants



The study was approved by the ethical committee of the Faculty of Social Sciences, Radboud University, Nijmegen, the Netherlands. The study is registered at the Australian New Zealand Clinical Trials Registry: ACTRN12614001179628.

Setting and Procedure

The study took place from January through March 2014 and lasted for a total of nine weeks (baseline measurements were taken in the first week, followed by the intervention during the following eight weeks). Prior to the intervention, all children completed the baseline questionnaire at their schools concerning their consumption behaviors and other factors related to water drinking.

Along with the baseline questionnaire, the children completed sociometric questions to identify the influential peers by means of peer nominations. Identical measures were assessed eight weeks after the intervention was started. In the post-intervention questionnaire, children were asked to give a description of the aim of the study. Most children wrote down an aim in line with or related to water consumption. None of the children except the influence agents indicated that the study was an intervention using the power of peer influence to promote water consumption.

Researchers delivered the training of the influence agents during school hours in one session that lasted 90 min. The aim of the training was to give influence agents the knowledge and skills to promote water consumption within their social networks. More specifically, the objectives of the training were: (1) to emphasize the benefits of water, (2) to encourage influence agents to consume more water themselves, and (3) to teach them how they could promote water consumption within their social networks. To assess the influence agents' current knowledge about the health and environmental benefits of water drinking, the training started by making a word web. Afterwards, the researchers highlighted the benefits of water and also showed a short movie-fragment about the problems for animals associated with the Great Pacific garbage patch. One way to reduce this garbage patch is by drinking tap water from reusable bottles.

Based on self-persuasion theory (Aronson, 1999), the influence agents were then asked to generate arguments on how to consume more water themselves (Miller & Wozniak, 2001; Mussweiler & Neumann, 2000). After that, their role as influence agent was explained and they were asked whether they were willing to take on this role. All children accepted this role. The influence agents were then asked to think about possible ways through which they could promote water consumption among their peers. From these options, drinking more water themselves and spreading the health and environmental benefits of water were discussed explicitly. Based on the insights of self-determination theory (Deci & Ryan, 1985; Soenens & Vansteenkiste, 2010) it was emphasized that the influence agents should decide for themselves how they wished to encourage their peers to drink more water. In addition, they received a reusable water bottle to stimulate water consumption among their peers.

Two follow-up sessions (one and four weeks after the training) provided researchers the opportunity to offer visible support, resolve any problems that the influence agents experienced in their role, and refresh the information that was discussed in the initial training.

Measures

Sociometric Questions

Five peer nomination items were used to identify the most influential children in each classroom. The children were asked to nominate up to five classmates whom they "respected", "wanted to be like", "looked up to", "went to for advice", and "regarded as good leaders" (Campbell et al., 2008; Starkey et al., 2009). In the intervention schools, children who received the most nominations were trained as influence agents to promote water consumption within their social networks for eight weeks. To ensure gender balance in proportion to the composition of the class, 15% of boys and 15% of girls with the most nominations over all questions were selected (Campbell et al., 2008; Starkey et al., 2009).

Water Consumption

At baseline and immediately after the intervention, children were asked to report how much water they drank on a school day and on a weekend day (Haerens et al., 2008). Response categories ranged from 0 = 'zero glasses per day' to 5 = 'five glasses per day'. Glasses also equaled cans, bottles, and packages. A total score for water consumption was constructed by averaging the school and weekend day items, which demonstrated good internal consistency (Spearman-Brown$_{baseline}$ = .83; Spearman-Brown$_{post\text{-}intervention}$ = .86).

Sugar-Sweetened Beverage Consumption

The consumption of sugar-sweetened beverages (SSBs) was measured by asking children at baseline and post-intervention to indicate on the same 6-point scale, ranging from 0 = 'zero glasses per day' to 5 = 'five glasses per day', how many glasses of juice they drank on a school day and on a weekend day. The same questions were asked for soda and energy drinks (Haerens et al., 2008). A score for SSB consumption was constructed by averaging the six items, which demonstrated acceptable internal consistency (Cronbach's alpha$_{baseline}$= .69; Cronbach's alpha$_{post\text{-}intervention}$ = .65).

Water Drinking Intentions

Behavioral intentions were measured at baseline and post-intervention with a scale on soda beverages (Kassem, Lee, Modeste, & Johnston, 2003) adjusted to water consumption: "Do you intend to drink more water on schooldays?" and "Do you intend to drink more water on weekend days?". Response categories ranged from 1 = 'no, certainly not' to 4 = 'yes, for sure'. A total score for water drinking intentions was constructed by averaging the school and weekend day items, which demonstrated good internal consistency (Spearman-Brown$_{baseline}$ = .76; Spearman-Brown$_{post\text{-}intervention}$ = .78).

Thirst

In line with previous research on consumption behavior and the role of hunger status (e.g., Bevelander et al., 2012) the children were asked how thirsty they were

at the time they filled in the baseline and post-intervention questionnaire. The children had to indicate how thirsty they were at that moment on a 4-point scale, ranging from 1 = 'not thirsty at all' to 4 = 'very thirsty'.

Statistical Analysis

Data were analyzed using SPSS version 21 (SPSS, Inc., Chicago, IL, US). Alpha was set at $p < .05$. First, independent-samples *t*-tests and Pearson's chi square tests were performed to examine whether the randomization resulted in a balanced distribution across the control and intervention condition. To determine whether we had to control for age, sex, and thirst in the main analysis, Pearson's correlations were performed for these variables with water consumption, SSB consumption, and water drinking intentions. For the main analyses, we used a two-way repeated measure MANCOVA with time (baseline vs. post-intervention) and condition (intervention vs. control) as the independent variables and three dependent variables: water consumption, SSB consumption, and water drinking intentions. Statistically significant main effects on condition or time, or an interaction between time and condition on water drinking, SSB consumption, and water drinking intentions were further examined by contrast comparisons or pairwise comparisons with Bonferroni correction.

The same analyses were repeated without the influence agents to examine whether the effect of the intervention was driven by the behaviors and intentions of the influence agents. Furthermore, paired sample *t*-tests were carried out to explore the effect of the training on the water and SSB consumption and water drinking intentions of the influence agents. Effect sizes for the *F*-tests were expressed as partial eta-squared ($p\eta^2$) and interpreted as small, medium, and large based on the values .01, .06, and .14, respectively (Stevens, 2009).

RESULTS

Randomization Check

To check whether there were differences between the control and intervention condition on age, thirst, water consumption, SSB consumption, and water drinking

intentions independent-samples *t*-tests were conducted. Pearson's chi-square tests were performed to check whether there were differences in sex. Table 2.1 summarizes the means and standard deviations (*SD*s) for all variables across the conditions. No differences ($p > .05$) were found between the intervention and control condition, which indicated that the randomization was successful.

Table 2.1 Randomization checks of the variables measured by control and intervention condition[1]

	Intervention (n = 106)	Control (n = 104)	Total (N = 210)	p-value[2]
Age (y)	10.67 ± .78 9 – 13	10.83 ± .82 9 – 13	10.75 ± .80 9 – 13	.16
Boys/girls (n/n)	51 / 55	50 / 54	101 / 109	
Thirst	2.11 ± .79 1.00 – 4.00	2.09 ± .73 1.00 – 4.00	2.10 ± .75 1.00 – 4.00	.80
Water consumption	2.67 ± 1.40 0.00 – 5.00	2.37 ± 1.39 0.00 – 5.00	2.52 ± 1.40 0.00 – 5.00	.11
SSB consumption	1.28 ± .84 .17 – 5.00	1.18 ± .60 .17 – 2.83	1.23 ± .74 .17 – 5.00	.30
Water drinking intentions	2.83 ± .75 1.00 – 4.00	2.75 ± .74 1.00 – 4.00	2.79 ± .74 1.00 – 4.00	.49

Note. [1] Values are presented in means ± SDs, min.–max. [2] Reflects the differences in total means between the conditions by independent-samples *t*-tests or Pearson's chi square test.

Main Analysis

Pearson's correlation analyses with all the dependent variables in the overall sample showed that thirst correlated significantly at both baseline and post-intervention with water consumption ($r_{baseline} = .27$, $p < .001$; $r_{post\text{-}intervention} = .23$, $p = .001$) and water drinking intentions ($r_{baseline} = .15$, $p = .032$; $r_{post\text{-}intervention} = .23$, $p = .001$). However, thirst only correlated marginally significant with SSB consumption at post-intervention ($r_{baseline} = .09$, $p = .199$; $r_{post\text{-}intervention} = .13$, $p = .052$). This was not the case for age and sex ($p > .05$). To make sure that thirst did not confound the effects, we included thirst at both time points as covariates in the main analysis.

To examine whether children in the intervention condition reported consuming more water, less SSBs, and stronger intentions to drink water post-intervention, compared to those in the control condition, a two-way repeated measures MANCOVA was performed. There was a significant multivariate interaction effect

between condition and time (V = .07, F(3,204) = 5.18, p = .002, $p\eta^2$ = .07) on the dependent variables. Furthermore, the model showed a significant multivariate main effect across condition (regardless of time points) (V = .04, F(3,204) = 2.99, p = .032, $p\eta^2$ = .04) on the three dependent variables, but not across time (regardless of condition) (V = .02, F(3,204) = 1.06, p = .367). In addition, the covariates thirst at baseline and post-intervention had a significant effect on the dependent variables (V = .05, F(3,204) = 3.74, p = .012, $p\eta^2$ = .05; V = .05, F(3,204) = 3.43, p = .018, $p\eta^2$ = .05, respectively). Further interpretation of the multivariate interaction effect between condition and time are presented below in the univariate outcomes of the multivariate model adjusting for thirst.

Water Consumption

There was a significant main effect for condition (F(1,206) = 7.59, p = .006, $p\eta^2$ = .04), but not for time (F(1,206) = .16, p = .689) on water consumption. More importantly, there was a significant interaction effect between condition and time (F(1,206) = 5.41, p = .021, $p\eta^2$ = .03) on water consumption, indicating that changes in water consumption differed for children in the intervention and control conditions. Posthoc contrast comparisons showed a significant difference in water consumption over time for the intervention condition (M_{baseline} = 2.67 ± SEM .13; $M_{\text{post-intervention}}$ = 2.92 ± SEM .14; p = .018), but not for the control condition (M_{baseline} = 2.37 ± SEM 0.13; $M_{\text{post-intervention}}$ = 2.27 ± SEM .14; p = .360). This means that children who were exposed to the social network-based intervention reported a significant increase in their water drinking compared to the children who were not exposed to the intervention.

Sugar-Sweetened Beverage Consumption

There were no significant main effects for condition (F(1,206) = .003, p = .957) or time (F(1,206) = 2.46, p = .118); but a significant interaction effect between condition and time (F(1,206) = 6.08, p = .015, $p\eta^2$ = .03) on SSB consumption.

This indicates that changes in SSB consumption differed for children in the intervention and control conditions[1]. Posthoc contrast comparisons showed a significant difference in SSB consumption over time for the intervention condition ($M_{baseline}$ = 1.28 ± *SEM* .07; $M_{post\text{-}intervention}$ 1.06 ± *SEM* .06; $p < .001$), but not for the control condition ($M_{baseline}$ = 1.18 ± *SEM* .07; $M_{post\text{-}intervention}$ 1.15 ± *SEM* .06; $p = .596$). This indicates that children who were exposed to the social network-based intervention reported drinking significantly less SSB over time than children who were not exposed to the intervention.

Water Drinking Intentions

There was a marginal significant main effect for condition ($F(1,206) = 3.34$, $p = .069$, $p\eta^2 = .02$) and no significant main effect for time ($F(1,206) = .56$, $p = .454$) on water drinking intentions. More importantly, there was a significant interaction effect between condition and time ($F(1,206) = 3.93$, $p = .049$, $p\eta^2 = .02$) on water drinking intentions, indicating that changes in water drinking intentions differed for children in the intervention and control conditions. Posthoc contrast comparisons showed a significant difference in water drinking intentions over time for the control condition ($M_{baseline}$ = 2.75 ± *SEM* .07; $M_{post\text{-}intervention}$ = 2.60 ± *SEM* .07; $p = .026$), but not for the experimental condition ($M_{baseline}$ = 2.83 ± *SEM* .07; $M_{post\text{-}intervention}$ = 2.86 ± *SEM* .07; $p = .576$). The findings indicated that children who were exposed to the intervention did not report a change in their water drinking intentions over time, whereas the children in the control condition reported a decrease in their water drinking intentions.

Additional Analyses

The same analyses were performed in the sample excluding the influence agents (n = 185) to investigate whether the effect of the intervention was driven by the behavior and intentions of the influence agents. Similar results were found for the multivariate model, with a significant interaction effect between condition and time ($V = .06$, $F(3,179) = 3.89$, $p = .010$, $p\eta^2 = .06$) on the three dependent variables

[1]The SSB consumption measure at both baseline and post-intervention were positively skewed. However, the results were identical when using the raw and logarithmically transformed scores; therefore, the reported analyses are based on the raw scores.

and marginal significant main effects for condition and time (p = .086 and p = .092, respectively). The univariate outcomes of the multivariate model showed weaker but comparable findings. Significant and marginal significant interaction effects were found between condition and time on water drinking (F(1,181) = 3.64, p = .058, $p\eta^2$ = .02), SSB consumption (F(1,181) = 5.56, p =.019, $p\eta^2$ = .03) and water drinking intentions (F(1,181) = 2.81, p = .095, $p\eta^2$ = .02). For water drinking, posthoc analyses showed that children in the intervention condition reported a marginally significant increase in their water consumption over time ($M_{baseline}$ = 2.68 ± *SEM* .15; $M_{post\text{-}intervention}$ = 2.90 ± *SEM* .16; p = .080), which was not the case for children in the control condition (p = .376). For SSB consumption, the children who were exposed to the social network-based intervention reported a significant decrease in their SSB consumption over time ($M_{baseline}$ = 1.34 ± *SEM* .08; $M_{post\text{-}intervention}$ = 1.11 ± *SEM* .07; $p < .001$), but not in the control condition (p = .610). For water drinking intentions, the children in the control condition reported a significant decrease over time ($M_{baseline}$ = 2.76 ± *SEM* .07; $M_{post\text{-}intervention}$ = 2.60 ± *SEM* .07; p = .025). This was not found for the children in the intervention condition (p = .814).

A paired sample *t*-test was performed to explore the effect of the intervention on the water drinking behaviors and intentions of the influence agents (n = 25). The influence agents reported a marginal significant increase in their water consumption ($M_{baseline}$ = 2.64 ± *SEM* .28; $M_{post\text{-}intervention}$ = 3.00 ± *SEM* .27; p =.056) and a marginally significant decrease in their SSB consumption over time ($M_{baseline}$ = 1.10 ± *SEM* .13; $M_{post\text{-}intervention}$ = .88 ± *SEM* .10; p = .071). The influence agents did not report a significant change in their water drinking intentions over time (p = .540).

DISCUSSION

The *Share* H_2O intervention aimed to promote water consumption among primary schoolchildren by exposing children to influence agents from their own classroom. In the present pilot study, we tested the effectiveness of this intervention by examining its impact on children's self-reported water drinking behaviors. Consistent with our expectations, the intervention with influence agents encouraging their peers to consume more water resulted in children reporting an

increase in their water drinking (H1) and a decrease in their SSB consumption (H2) over time. These findings are in line with the growing body of peer influence research demonstrating that children model the consumption behaviors of their peers (Bevelander et al., 2012; Cruwys et al., 2015). That is, the children could have consumed more or less according to a potential social norm that was set by a peer. Previous studies have shown that encouragement by peers can increase acceptance and consumption of foods (Hendy, 2002; Hendy & Raudenbush, 2000) and even seeing peers consume food children do not like can increase their preferences and intake of these foods (Birch, 1980). This could also have been the case in the present study, given the fact that the influence agents successfully promoted water consumption which also led to their peers reporting a decrease in their SSB consumption. Nevertheless, we do not know whether children replaced their SSB consumption by drinking (more) water, or that the children who were exposed to the social network-based intervention modeled the influence agents in drinking less SSBs. Further research is needed to unravel by which of these mechanisms the decrease of SSB consumption could be explained.

Notably, this was the first intervention study aimed at water drinking that incorporated the social modeling mechanism in conjunction with peer status among primary school children. The findings suggest that it is important to take the status of peers into account when targeting behavioral change processes in social networks. Previous experimental studies in adolescents have shown similar effects of peers on alcohol consumption (Larsen, Engels, Souren, Granic, & Overbeek, 2010; Teunissen et al., 2012), where high status peers were more influential than low status peers in reducing their willingness to drink alcoholic beverages (Teunissen et al., 2012). The adolescents accepted and internalized the anti-alcohol norms of their popular peers (Teunissen et al., 2012). This could also have been the case in the present study; however, we can only speculate whether the selected influence agents were more influential in improving children's water consumption behaviors. Nevertheless, the children in the intervention reported an increase in their water drinking and a decrease in their SSB consumption

compared to the children in the control conditions. Future research should investigate the status of peers into more detail.

Contrary to expectations, the children exposed to the social network-based intervention did not report a change in their intentions (H3). There are several explanations for the stability (instead of an increase) in water drinking intentions in the intervention condition. First, it might be that the children modeled the drinking behavior of their peers unconsciously, while self-reported intentions require being conscious of one's behavior and plans (Cruwys et al., 2015; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Research has shown that children follow the food intake behavior of their peers, even after being told explicitly what social modeling behavior is and having practiced social influence situations (Bevelander, Engels, Anschütz, & Wansink, 2013). We acknowledge that this does not explain why the influence agents maintained (rather than increased) their water drinking intentions, given they were the ones who were being modeled. A possible explanation might be that the influence agents were not able to report greater water drinking intentions, because they already consumed more water. A second explanation for the stability in the children's intentions might be that measuring an individual's intention to change might not provide a complete picture of actual behavior change (Sheeran, 2002; Sniehotta, Scholz, & Schwarzer, 2005). To explain this discrepancy between intention and behavior other possible mediators must be examined (Sniehotta et al., 2005).

Additionally, we found that the nonexposed children reported a decrease in their water drinking intentions over time. This significant decrease in water drinking intentions could have been caused by frustration resulted from asking the nonexposed children about their intentions for a second time. Unlike the children in the intervention condition, the nonexposed children were not motivated to uphold their opinion towards water, which might explain why the decrease was only observed in the control condition.

Furthermore, it is important to note that this study was the first that incorporated self-persuasion theory (i.e., motivating individuals to persuade themselves;

Aronson, 1999; Miller & Wozniak, 2001; Mussweiler & Neumann, 2000) and the self-determination theory (i.e., supporting the individuals' need for autonomy by providing choices; Deci & Ryan, 1985; Soenens & Vansteenkiste, 2010) in the training of the influence agents. It might be the case that if the influence agents were not asked whether they actually would like to take on this role, that they may have felt that the role of an influence agent was imposed on them. This could have led to them not promoting the desired behaviors, because drinking water is presumably not considered a popular beverage among this age group (Drewnowski et al., 2013). Reactance might have occurred (Brehm, 1966), leading the influence agents to reject water drinking as beneficial. Our findings suggest that the training influenced them positively, given the reported increase in their water consumption. Nevertheless, these explanations remain speculative and future research is necessary to examine whether the training increased influence agents' intrinsic motivation and level of self-persuasion immediately after the training. However, it is important to note that, overall, the influence agents reacted enthusiastically at the end of the training and expressed their willingness to help make drinking water a trend.

Some limitations should be addressed in interpreting the findings of this pilot study. First, although the reported increase in water consumption (and decrease in SSB consumption) was significant, it is important to mention that the found effects were small e with an average increase of water consumption of less than half a serving. Related to this, beverage consumption was assessed by self-report measures only. An additional methodology would have been to use a more direct measurement, such as the use of flow meters attached to the schools' water fountains to determine the amount of water dispensed from these fountains (Loughridge & Barratt, 2005). Unfortunately, this was not possible in our study. Future studies should seek to replicate our findings using additional means to evaluate beverages consumption. Second, the sample was relatively small, future research is needed to replicate this study in a larger and more diverse sample. This is especially important when it comes to analyzing the data without the influence

agents. Third, and related to the previous point, it is important to disentangle the effect from the training itself from the effect of the influence agents encouraging their peers to drink water. An approach for this could be to compare the impact of the training delivered to the whole network to delivering the training to the influence agents (as was done in the current study).

Fourth, we focused only on short-term effects of the intervention. Although the results of this study are promising for improving children's consumption behaviors, a next step would be to replicate this study and to include follow-up assessments to examine potential long-term effects. Finally, our study identified the influential peers by means of five questions about respect, good leadership, identification, and advice seeking. It might be that various peers are influential in different ways with regard to specific behaviors. For example, a child might function as a role model with regard to water consumption, but not with regard to eating healthy, physical activity, smoking, or drug use. In order to fully understand the role of influence agents in health interventions, future research should continue to explore the different types of characteristics (e.g., social status; Rogers, 2010) or personality traits (e.g., self-esteem; Bevelander, Anschütz, Creemers, Kleinjan, & Engels, 2013) that make some individuals more influential than others. For health professionals it is highly relevant to know which characteristics are most important for positive health behavior change among children.

In conclusion, the present pilot study was the first intervention study aimed at water drinking that incorporated the social modeling mechanism in conjunction with peer status among primary school children. Findings showed that a social network-based intervention stimulating peer influence on water consumption is a very promising method to improve children's drinking behaviors. Our findings underline the importance of peers and the social context for health interventions, suggesting a promising avenue for future interventions and intervention research. In addition, we found that a sole focus on promoting water can not only increase children's self-reported water consumption, but also reduce their SSB consumption.

3

AN INTEGRATED MODEL OF FRUIT, VEGETABLE, AND WATER INTAKE IN YOUNG ADOLESCENTS

This chapter is published as:
Smit, C. R., de Leeuw, R. N., Bevelander, K. E., Burk, W. J., Buijs, L., van Woudenberg, T. J., & Buijzen, M. (2018). An integrated model of fruit, vegetable, and water intake in young adolescents. *Health Psychology,* 37, 1159-1167. https://doi.org/10.1037/hea0000691

ABSTRACT

In this study, we tested an integrated model for why young adolescents consume fruit, vegetables, and water. The model was based on evidence from studies applying three dominant theoretical approaches, including planned behavior, social norms, and intrinsic motivation. The integrated model was tested with structural equation modeling using four data-collection waves of the *MyMovez* project in which 953 young adolescents (53.9% girls; M_{age} = 11.19, SD_{age} = 1.36) participated. Self-reported measures were used to assess young adolescents' fruit, vegetable, and water consumption, self-efficacy, attitude, social norms of parents and peers, behavioral intentions, and intrinsic motivation. The analyses revealed that young adolescents' intrinsic motivation to eat fruits and vegetables or drink water predicted changes in their fruit, vegetable, and water consumption. Furthermore, adolescents' perceived parental descriptive norms (i.e., perception of the prevalence of their parents' water consumption) also predicted changes, but only for water consumption. The current findings show that young adolescents' intrinsic motivation (and, to some extent, parental social norms) is the strongest predictor of their consumption of fruit, vegetables, and water. It is important to note, behavioral intentions do not predict their actual behavior over time. Consequently, interventions should focus on increasing young adolescents' intrinsic motivation to perform the targeted behavior while incorporating the influence of the social context.

BACKGROUND

Obesity among young adolescents remains a public health priority worldwide (WHO, 2020). Critical contributors of youth overweight and obesity include the consumption of highly energy-dense foods and sugar-sweetened beverages (Hu, 2013; Stelmach-Mardas et al., 2016). Researchers have shown that increasing fruit, vegetable, and water consumption can be effective ways to decrease overweight and obesity (Hu, 2013; Lin & Morrison, 2002). To improve interventions for obesity prevention, it is essential to gain insight into the mechanisms predicting dietary behaviors. Therefore, to bring guidance to the design and implementation of future studies, this paper integrates elements of three dominant theoretical constructs to predict young adolescents' consumption of fruit, vegetables, and water: planned behavior, social norms, and intrinsic motivation.

One of the most widely used models to predict behavioral change is the theory of planned behavior, which asserts that an individual's behavioral intention is the most important predictor of behavioral change (Ajzen, 1985; Conner, Norman, & Bell, 2002). According to the theory of planned behavior, an individual's intention to perform the behavior is predicted by (a) attitude toward the behavior (the self-perceived evaluation of the behavior), (b) self-efficacy (an individual's belief that he or she is capable and in control of the behavior), and (c) subjective norms (an individual's perceptions of what others consider appropriate concerning the behavior). In turn, behavioral intention predicts the individual's actual behavior (Ajzen, 1985; Conner et al., 2002).

Research investigating the theory of planned behavior in relation to dietary behaviors is mostly cross-sectional and has yielded mixed findings. Several cross-sectional studies have confirmed theory of planned behavior assumptions, finding that attitude, self-efficacy, and subjective norms relate to intentions that, in turn, relate to dietary behaviors (for review, see Riebl et al., 2015). However, longitudinal research has shown mixed findings in the prediction of changes in long-term dietary behaviors (for review, see Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008). This so-called "intention–behavior" gap reflects a common observation in

health-psychology research (Sheeran, 2002). These findings strongly suggest that the theory of planned behavior model does not sufficiently predict changes in dietary behavior.

A first possible explanation—and, thereby, a possible way to strengthen the predictive power and extend the theory of planned behavior model—might lie in the limited conceptualization of the subjective norm construct. Research has shown that the subjective norms construct in the theory of planned behavior is generally a weak predictor of intentions, which might indicate a need to adjust this norm (e.g., Armitage & Conner, 2001). However, in recent years, the rapidly expanding research of the social norms domain has further scrutinized this construct in relation to dietary intake, providing more in-depth insight about the nature and mechanisms of social norms (e.g., Higgs, 2015; Jones & Robinson, 2017; Robinson, Thomas, Aveyard, & Higgs, 2014). Promising for the theory of planned behavior model, social norms research has brought forward the importance of distinguishing between not only different types, but also different sources of normative influences in predicting dietary behaviors (for review, see Jones & Robinson, 2017; Robinson et al., 2014).

With regard to the types of social norms, the literature makes a distinction between descriptive (i.e., the perceptions of the prevalence of others' behavior) and injunctive norms (i.e., the perceptions of what others consider appropriate; Cialdini, Kallgren, & Reno, 1991). Parents and peers have been shown to be the principal sources of childhood social norms in relation to dietary behaviors (Patrick & Nicklas, 2005). Parents strongly influence their children's dietary behaviors (Pearson, Biddle, & Gorely, 2009); however, as children get older, their peers become increasingly influential of their eating behaviors (Salvy et al., 2012). Studies investigating dietary behaviors have found that social norms affect not only behavioral intention (Stok, De Ridder, De Vet, & De Wit, 2014), but also actual consumption (Jones & Robinson, 2017; Pedersen, Grønhøj, & Thøgersen, 2015). Nevertheless, it remains unclear whether either type of norm from either source predicts changes in dietary behaviors in the long run, taking into account other

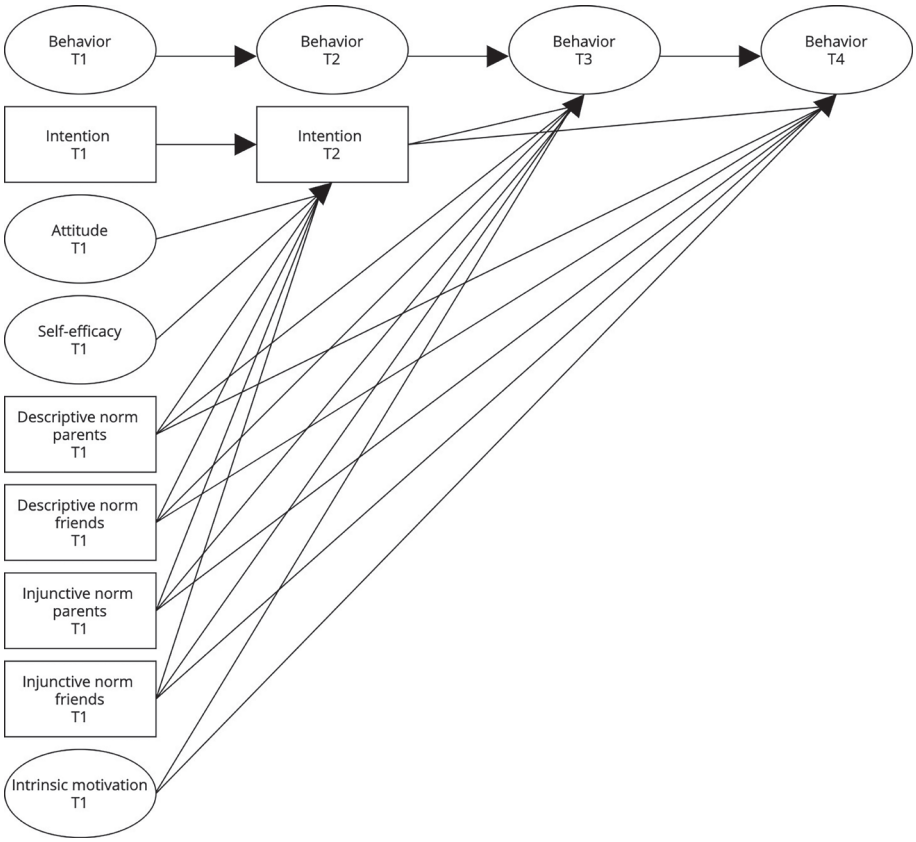
behavioral predictors. Therefore, this study expands the social norms construct in the theory of planned behavior model by distinguishing between different types and sources of social norms. In addition, the study integrates insights from the social norms approach by adding direct relations between its constructs and individuals' behaviors.

A second possible explanation for the mixed evidence of theory of planned behavior in predicting dietary intake—thereby a promising way to integrate a different theoretical perspective—can be found in motivational theories of behavioral change. Notably, the theory of planned behavior does not incorporate an individual's motivation to engage in a health-related behavior (Brown, Hagger, Morrissey, & Hamilton, 2018; Chatzisarantis, Hagger, Smith, & Sage, 2006). However, research based on self-determination theory shows that motivation, especially intrinsic motivation, is an essential determinant of behavioral change (Ryan et al., 2008), which is the tendency for individuals to engage in a behavior for their own sake, interest, or pleasure (Deci & Ryan, 1985). Intrinsic motivation to adopt healthier lifestyle patterns, such as healthy eating, fruit and vegetable consumption, and exercising, has been found to directly predict the actual adoption of these behaviors in the long term (e.g., Mata et al., 2009; Pelletier et al., 2004; Silva et al., 2011; Teixeira et al., 2015). Therefore, for this study, we posited a direct path between the motivational construct (i.e., intrinsic motivation) and actual dietary intake.

Thus, the current state of knowledge indicates that there is a need for integrating different theoretical perspectives to determine which mechanism is the most predictive of dietary intake. As yet, it is uncertain how the main constructs in the three approaches compare to one another in predicting behavioral change. To this end, in the current study, we tested an integrated model, which is depicted in Figure 3.1. Based on theory of planned behavior research, the model tests the hypothesis that attitude, self-efficacy, and subjective norms predict behavioral intentions, which, in turn, predict subsequent changes in fruit, vegetable, and water consumption, either poorly or not at all. Based on social norms research,

the model distinguishes between two types, descriptive norms and injunctive norms, and two sources, parents and peers. In addition, the model tests the hypothesis that all the social norm constructs predict changes in consumption behavior. Integrating the self-determination theory perspective, the model tests whether a direct relationship exists between intrinsic motivation and changes in young adolescents' consumption.

Figure 3.1 SEM model predicting fruit and vegetable consumption



Note. Boxes represent observed variables and ellipses latent variables. The same conceptual model was tested for water consumption, except that behavior was an observed variable. The paths in the conceptual model represent regression paths that were estimated using structural equation modelling. Sex, school cohort, *z*-BMI and hunger/ thirst were included in both SEM models as covariates.

METHOD

Participants

The first four data-collection waves employed data from the *MyMovez* research program (MyMovez, 2017). The aim of this research program was to unravel young adolescents' social network structures in combination with individual, psychosocial, and other environmental factors related to energy intake and expenditure (see Bevelander et al., 2018 for a detailed description of the research program). The current sample of the study consists of 953 young adolescents who participated in at least one of the four data-collection waves. All schools following a regular education program were eligible for participation. The initial age of the participants ranged between 8 and 15 years, with a mean age of 11.19 years (*SD* = 1.36). Boys and girls were represented about equally: 53.9% of the participants were girls. Of the total sample, 453 (47.5%) participants attended primary school and 500 (52.5%) attended secondary school. The majority of the participants were of Dutch origin (> 90%). Most of the participants had normal weight (74.4%); 7.8% were underweight, 14.2% were overweight, and 3.6% were extremely overweight, that is, obese (Talma, Schonbeck, Bakker, Hirasing, & Van Buuren, 2010).

Procedure

Participants were recruited through their primary and secondary schools. After gaining permission to participate from the schools' directors, active written consent was obtained from participants' caretakers and the participants themselves. At the start of each data-collection wave, new participants had the opportunity to participate in the *MyMovez* research program (MyMovez, 2017), In addition, some participants dropped out during data collection, which resulted in different sample sizes for each data wave. Data collection for the baseline assessment (T1) took place in February 2016. Measurements for the second (T2), third (T3), and fourth (T4) waves took place in April 2016, June 2016, and February 2017, respectively. The number of participating young adolescents was 792 at T1, 852 at T2, 824 at T3, and 671 at T4.

During all waves, participants received the *MyMovez Wearable Lab* for seven calendar days. The *Wearable Lab* consisted of a smartphone with a preinstalled research application and an activity-tracking bracelet (Bevelander et al., 2018; MyMovez, 2017). The research application served as the measurement tool for the questionnaires. Participants received daily questionnaires at random time points between 7:00 a.m. and 7:30 p.m., but not during school hours, except for school breaks. The research application included an avatar, a puzzle game (Zoko), and a social media platform. Through this social media platform, the participants could contact their peers and the researchers. The *MyMovez* research program was approved by the ethics committee on social sciences and ethical review board from the European Research Council (617253).

Measures

Fruit and Vegetable Consumption

To assess fruit consumption, participants indicated on three different days (i.e., every other day during each data wave) on a 7-point scale ranging from 0 = 'none' to 6 = 'six or more', how many pieces (i.e., units) of fruit they had consumed the day before (Ocke et al., 1997). The same question was asked to assess vegetable consumption. One unit was defined as one apple or pear, or a handful of grapes, snack tomatoes, or cucumbers. A more detailed description of the food items can be found in the *MyMovez* protocol (Bevelander et al., 2018). Averaging the participants' reported consumption over the three days produced a total score for fruit and vegetable consumption.

Water Consumption

To assess water consumption, participants indicated on three different days (i.e., every other day during each data wave) on an 8-point scale, ranging from 0 = 'zero glasses per day' to 7 = 'seven or more glasses per day', how much water they had drunk the day before (Ocke et al., 1997; Smit et al., 2016). An illustration was used to instruct the participants that "one glass" also meant one can, bottle, or package of approximately 200 ml. Averaging the participants' reported consumption over the three days led to the total score for water consumption.

Attitude

Based on Zebregs, van den Putte, de Graaf, Lammers, and Neijens (2015) study, two items were used to measure participants' attitude toward eating fruits and vegetables. The sentence "I find eating fruits and vegetables as a snack . . ." 'very unpleasant' (1) to 'very pleasant' (4) and 'very distasteful' (1) to 'very tasteful' (4). Attitude toward drinking water was measured with the sentence: "I find drinking water . . ." 'very unpleasant' (1) to 'very pleasant' (4) and 'very distasteful' (1) to 'very tasteful' (4). Averaging the two items produced the total score for attitude toward eating fruit and vegetables or drinking water, which demonstrated adequate internal consistency (Spearman-Brown *r*s = .79 and .85, respectively).

Self-Efficacy

Participants' self-efficacy regarding fruit and vegetable consumption was assessed using two items: (1) "Do you think you will succeed in eating more fruits and vegetables as a snack?" and (2) "Do you think it is easy for you to eat more fruits and vegetables as a snack?" (van der Horst et al., 2007). The same two items were also asked of water consumption. Response options ranged from 1 = 'no, certainly do not' to 6 = 'yes, certainly do'. Averaging the two items produced the total score for self-efficacy regarding fruit and vegetable consumption and water consumption, which demonstrated adequate internal consistency (Spearman-Brown *r*s = .79 and .85, respectively).

Intentions

Participants' intentions to eat fruit and vegetables was assessed with one item: "Do you intend to eat more fruits and vegetables as a snack?" (Lien, Lytle, & Komro, 2002; Smit et al., 2016). The same item was used to assess participants' Intentions to drink water. Both measures had a 6-point scale ranging from 1 = 'no, certainly do not' to 6 = 'yes, certainly do'. Several studies have used similar measures to access participants' Intentions (e.g., De Bourdeaudhuij et al., 2005; Ezendam, Evans, Stigler, Brug, & Oenema, 2010).

Descriptive Norms

Participants' perception of others' behavior was assessed with the following item separately for parents and friends: "How often do your parents/friends eat fruits and vegetables as a snack?" (Pedersen et al., 2015). The same items were also used for water consumption. Response options ranged from 1 = 'never' to 6 = 'always'.

Injunctive Norms

Participants' perception of what others consider appropriate was assessed with the following item separately for parents and friends: "Do you experience that your parents/friends think you should eat fruits and vegetables as a snack?" (Pedersen et al., 2015). The same items were also used for water consumption. Response options ranged from 1 = 'no, certainly do not' to 6 = 'yes, certainly do'.

Intrinsic Motivation

Intrinsic Motivation to eat fruits and vegetables was assessed with four items, based on the Health Care self-determination theory package (Williams, Ryan, & Deci, 2017). Participants were asked: "Do you eat fruits and vegetables as a snack because you . . . (1) like it?, (2) enjoy it?, (3) want this yourself? and (4) think it is pleasant?" The same items were also used to assess participants' intrinsic motivation to drink water. Response options ranged from 1 = 'no, certainly do not' to 6 = 'yes, certainly do'. Several studies have used similar measures to access participants' intrinsic motivation (Ryan & Connell, 1989; Vansteenkiste, Claes, Soenens, & Verstuyf, 2013). Principal axis factoring analyses showed that one factor could be extracted from the scale items, with an eigenvalue higher than 1 explaining 71.4% of the variance for fruit and vegetable consumption and 69.1% for water consumption. Also, the inspection of the scree plots revealed a clear break after the first factor, indicating that the four items reflected one construct. A total score for intrinsic motivation to eat fruits and vegetables or drink water was constructed by averaging the four items, which demonstrated good internal consistency (Cronbach's αs = .87 and .85, respectively).

Covariates

In the analyses, participants' school cohort, sex, body-mass index z score (z-BMI), and hunger/thirst were included as control variables. School cohort was considered in the analysis by rating whether the participant was in 0 = 'primary school' or 1 = 'secondary school'. The height and body weight of the participants were individually measured according to standard procedures (without shoes but fully clothed) at the participating schools during T2 and 1 year later during T4. Height was measured to the nearest 0.1 cm and body weight was measured to the nearest 0.1 kg. The BMI for each child was calculated using the following formula: weight over height squared (kg/m^2.) Z-BMI was calculated and represented standards for Dutch children (Schönbeck et al., 2011). Hunger and thirst were assessed on a Visual Analogue Scale (0 cm = not hungry/thirsty; 15 cm = very hungry/very thirsty; Bevelander et al., 2012).

Strategy of Analyses

Descriptive statistics were calculated to examine means and standard deviations of all model items. Next, correlations among all model items were computed to assess bivariate associations. The primary analyses consisted of two structural equation models (SEMs) using Mplus Version 7.2 (Muthén & Muthén, 2012). The first SEM tested which predictors from the various theories were related to fruit and vegetable consumption over time; the second SEM tested the various predictors of water consumption (see Figure 3.1). The covariates (sex, school cohort, z-BMI and hunger/thirst) were included in both SEMs as predictors of participants' Behavioral Intentions and Behavior. For both models, Attitude, Self-Efficacy, and Intrinsic Motivation were included as latent constructs. For the model predicting fruit and vegetable consumption, the two fruit and vegetable consumption items were also used to form latent constructs at each assessment.

The models included regression paths for the behaviors from T1 to T2, T2 to T3, T3 to T4, and for Intentions from T1 to T2 to account for interindividual stability in the behavior. The parameters in the models were estimated applying the (full-information) maximum-likelihood estimator with robust standard errors (MLR in

Mplus) to account for missing values and potential deviations from multivariate normality. The fit of the models was assessed by the following fit indices: χ^2, CFI (comparative fit index, with a cut-off value of .95), and RMSEA (root mean square error of approximation, with a cut-off value of .06; (Hu & Bentler, 1999).

RESULTS

Descriptive Statistics

Means and standard deviations of all model items are reported in Table 3.1. Regarding participants' behaviors, findings revealed that the average fruit consumption per day ranged between 1.63 and 1.74 units across all waves; the average vegetable consumption per day ranged between .98 and 1.06 units. On average, the participants' reported water consumption to be between 2.47 and 3.04 glasses of water per day across all waves.

Table 3.1 Descriptive statistics for all model Items

	Fruit and vegetables			**Water**		
	M	***SD***	**Reported range**	***M***	***SD***	**Reported range**
Hunger/ Thirst T1	5.20	3.58	0-15	6.43	3.34	0-15
Hunger/ Thirst T2	5.54	3.98	0-15	6.37	3.85	0-15
Hunger/ Thirst T3	5.42	4.23	0-15	6.60	4.24	0-15
Hunger/ Thirst T4	5.64	4.12	0-15	6.28	3.90	0-15
Behavior T1						
Fruit	1.74	1.19	0-6			
Vegetables	1.00	1.23	0-6			
Water				3.04	1.59	0-7
Behavior T2						
Fruit	1.65	1.22	0-6			
Vegetables	.98	1.27	0-6			
Water				2.58	1.69	0-7
Behavior T3						
Fruit	1.63	1.35	0-6			
Vegetables	1.06	1.44	0-6			
Water				2.47	1.80	0-7
Behavior T4						
Fruit	1.65	1.22	0-6			
Vegetables	.99	1.26	0-6			
Water				2.67	1.75	0-7
Intention T1	3.93	1.59	1-6	4.11	1.59	1-6

	Fruit and vegetables			Water		
	M	***SD***	**Reported range**	***M***	***SD***	**Reported range**
Intention T2	3.89	1.57	1-6	4.09	1.61	1-6
Attitude T1						
Pleasant (item 1)	3.15	.77	1-4	3.25	.81	1-4
Tasteful (item 2)	3.37	.74	1-4	3.33	.74	1-4
Self-efficacy T1						
Succeed (item 1)	4.85	1.32	1-6	5.04	1.31	1-6
Easy (item 2)	4.67	1.44	1-6	4.91	1.37	1-6
Descriptive norm parents T1	4.01	1.31	1-6	4.33	1.21	1-6
Descriptive norm friends T1	3.54	1.13	1-6	3.64	1.18	1-6
Injunctive norm parents T1	4.75	1.45	1-6	4.77	1.53	1-6
Injunctive norm friends T1	3.29	1.64	1-6	3.25	1.76	1-6
Intrinsic motivation T1						
Like (item 1)	5.14	1.10	1-6	4.45	1.63	1-6
Enjoy (item 2)	4.90	1.28	1-6	4.18	1.68	1-6
Want (item 3)	5.32	1.20	1-6	5.30	1.31	1-6
Pleasant (item 4)	4.99	1.25	1-6	4.66	1.57	1-6

Note. These findings are derived from the total sample of children (N = 953); T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4.

Correlations Among Model Items

Regarding the model items involving fruit and vegetable consumption, Pearson's correlation analyses yielded the following significant relations (a complete overview of the correlations is available upon request). Participants' Intentions to eat more fruit and vegetables was consistently associated with their Attitude (pleasant: r = .25, p < .001; tasteful: r = .21, p < .001) and Self-Efficacy toward fruit and vegetable consumption (succeed: r = .36, p < .001; easy: r = .25, p < .001), Descriptive and Injunctive Norms of parents (r = .10, p = .029; r = .18, p < .001, respectively) and friends (r = .15, p = .001; r = .26, p < .001, respectively). Participants' fruit and vegetable consumption were less consistently associated with Intentions to eat more fruit and vegetables (T3 fruit: r = .11, p = .014; T4 fruit: r = .15, p = .003; T4 vegetable: r = .13, p = .007) and both Descriptive Norms (T3 fruit: r = .11, p = .014; T3 vegetable: r = .12, p = .006; T4 fruit: r = .19, p < .001) and Injunctive Norms of parents (T3 vegetable: r = .10, p = .044; T4 fruit: r = .13, p = .012). Intrinsic Motivation to eat fruit and vegetables was also less consistently associated with participants' fruit consumption (T3 like: r = 14, p = .002; enjoy: r = .16, p < .001; want: r = .11, p = .019; pleasant: r = .13, p = .004; T4 like: r = 14, p = .003; want:

r = .10, p = .039) and vegetable consumption (T3 like: r = 11, p = .020; enjoy: r = .11, p = .014; pleasant: r = .10, p = .029). Neither fruit consumption nor vegetable consumption was associated with the Injunctive Norms of friends.

Regarding the model items involving water consumption, findings show that participants' Intention to drink more water was consistently associated with their Attitude (pleasant: r = .22, p < .001; tasteful: r = .24, p < .001) and Self-Efficacy toward water consumption (succeed: r = .42, p < .001; easy: r = .33, p < .001), Descriptive and Injunctive Norms of parents (r = .20, p < .001; r = .22, p < .001, respectively) and friends (r = .19, p < .001; r = .25, p < .001, respectively). Participants' water consumption was also consistently associated with Intrinsic Motivation to drink water (T3 like: r = 17, p < .001; enjoy: r = .18, p < .001; want: r = .19, p < .001; pleasant: r = .23, p < .001; T4 like: r = 17, p < .001; enjoy: r = .17, p < .001; want: r = .17, p < .001; pleasant: r = .22, p < .001) and Descriptive Norms of parents (T3: r = .13, p = .003; T4: r = .22, p < .001). Water consumption was less consistently associated with the Descriptive Norms of friends (T4: r = .17, p = .001) and Injunctive Norms of parents (T4: r = .14, p = .009). Participants' water consumption was not associated with Intentions to drink more water or the Injunctive Norm of friends.

Model Findings

Fruit and Vegetable Consumption

The model investigating fruit and vegetable Consumption (see Figure 3.1) showed a good fit to the observed data, $\chi^2(249) = 489.75$, CFI = .94, and RMSEA = .03. Factor loadings of the latent constructs (Attitude, Self-Efficacy, Intrinsic Motivation, and Behavior) ranged from λ = .41 to λ = .91, p < .001. Table 3.2 presents all regression paths estimated in the model examining fruit and vegetable consumption. Self-Efficacy and Injunctive Norms of friends at T1 were the only statistically significant predictors of change in participants' Intentions to eat more fruit and vegetables from T1 to T2. The only statistically significant predictor of change in fruit and vegetable consumption was Intrinsic Motivation. Higher levels of Intrinsic Motivation to eat fruit and vegetables at T1 predicted increases in fruit and vegetable consumption from T2 to T3, but not from T3 to T4.

Water Consumption

The model examining water consumption showed a good fit to the observed data, $\chi^2(155) = 385.989$, CFI = .94, and RMSEA = .04. Factor loadings of the latent constructs (Attitude, Self-Efficacy, and Intrinsic Motivation) ranged from $\lambda = .73$ to $\lambda = .89$, $p < .001$. Model estimates indicated a similar pattern to the model predicting changes in fruit and vegetable consumption (see Table 3.2). Self-Efficacy at T1 predicted changes in participants' Intentions to drink water from T1 to T2. Participants' Intrinsic Motivation to drink water at T1 predicted changes in their water consumption from T2 to T3, as well as from T3 to T4. In addition, the Descriptive Norms of parents at T1 also predicted changes in participants' water consumption from T3 to T4.

Table 3.2 Standardized estimates and standard errors for the tested models

	Fruit and vegetables			Water		
	β	***SE***	***p*-value**	**β**	***SE***	***p*-value**
Regression paths on intention T2						
Attitude T1 → Intention T2	.00	.06	.949	.01	.05	.911
Self-efficacy T1 → Intention T2	.21	.08	.006	.20	.06	<.001
Descriptive norm parents T1 → Intention T2	-.06	.04	.161	.00	.04	.997
Descriptive norm friends T1 → Intention T2	.01	.05	.900	.01	.04	.816
Injunctive norm parents T1 → Intention T2	.01	.06	.804	.02	.05	.697
Injunctive norm friends T1 → Intention T2	.14	.05	.008	.06	.04	.167
Regression paths on Behavior T3						
Intention T2 → Behavior T3	-.01	.06	.831	.02	.05	.701
Descriptive norm parents T1 → Behavior T3	-.02	.08	.752	.05	.05	.349
Descriptive norm friends T1 → Behavior T3	-.00	.07	.983	-.04	.05	.490
Injunctive norm parents T1 → Behavior T3	-.04	.08	.629	.01	.06	.902
Injunctive norm friends T1 → Behavior T3	-.06	.08	.473	-.05	.05	.311
Intrinsic motivation T1 → Behavior T3	.17	.07	.012	.13	.04	.002
Regression paths on Behavior T4						
Intention T2 → Behavior T4	.11	.08	.161	-.08	.05	.095
Descriptive norm parents T1 → Behavior T4	.12	.09	.222	.13	.06	.019
Descriptive norm friends T1 → Behavior T4	-.04	.09	.629	.05	.06	.403
Injunctive norm parents T1 → Behavior T4	.09	.09	.331	.05	.06	.499
Injunctive norm friends T1 → Behavior T4	-.05	.10	.616	-.00	.06	.952
Intrinsic motivation T1 → Behavior T4	-.02	.09	.836	.11	.05	.024

	Fruit and vegetables			Water		
	β	*SE*	*p*-value	β	*SE*	*p*-value
Stability regression path						
Intention T1 → Intention T2	.31	.06	<.001	.37	.05	<.001
Behavior T1 → Behavior T2	.73	.06	<.001	.45	.04	<.001
Behavior T2 → Behavior T3	.67	.11	<.001	.49	.04	<.001
Behavior T3 → Behavior T4	.80	.14	<.001	.41	.05	<.001
Covariates						
Sex[1] → Intention T2	.09	.04	.010	.13	.03	<.001
Sex[1] → Behavior T1	.10	.04	.797	-.04	.03	.198
Sex[1] → Behavior T2	-.02	.04	.618	-.01	.03	.673
Sex[1] → Behavior T3	.04	.05	.498	.05	.04	.174
Sex[1] → Behavior T4	-.07	.06	.192	-.04	.04	.277
School cohort[2] → Intention T2	-.10	.04	.005	-.12	.03	<.001
School cohort[2] → Behavior T1	-.24	.04	<.001	.15	.03	<.001
School cohort[2] → Behavior T2	.04	.05	.381	-.02	.03	.524
School cohort[2] → Behavior T3	-.06	.06	.287	.09	.04	.017
School cohort[2] → Behavior T4	-.08	.06	.197	-.01	.04	.812
Time-varying covariates						
z-BMI T2 → Intention T2	.08	.03	.020	.10	.03	.003
z-BMI T2 → Behavior T1	.00	.04	.958	.02	.04	.508
z-BMI T2 → Behavior T2	-.02	.04	.636	-.01	.04	.794
z-BMI T2 → Behavior T3	.04	.05	.448	-.02	.04	.633
z-BMI T4 → Behavior T4	.06	.06	.304	.05	.04	.210
Hunger/ thirst T2 → Intention T2	-.00	.04	.984	.06	.04	.117
Hunger/ thirst T1 → Behavior T1	.11	.04	.005	.04	.04	.237
Hunger/ thirst T2 → Behavior T2	.03	.05	.599	.07	.04	.077
Hunger/ thirst T3 → Behavior T3	-.03	.05	.617	.01	.04	.800
Hunger/ thirst T4 → Behavior T4	.08	.06	.194	.08	.04	.081

Note. [1]0 = boy and 1 = girl; [2]0 = primary school and 1 = secondary school; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4.

Additional Analyses

Participants were asked to indicate whether they had different kinds of fruits and vegetables at home. To investigate whether availability at home played a role in predicting changes in fruit and vegetable consumption, the same model was also tested without the participants who reported never having fruit or vegetables at home (*n* = 27). Model estimates indicated a similar pattern to the SEM tested among the whole sample.

DISCUSSION

The present study was the first to examine an integrated model for why young adolescents consume fruit, vegetables, and water by integrating a variety of theoretical perspectives, including planned behavior, social norms, and intrinsic motivation. Findings demonstrated that intrinsic motivation to eat fruits and vegetables and drink water did predict changes in behavior. In addition, young adolescents' perceptions of how often their parents drank water (i.e., descriptive parental norms) also predicted behavioral change.

The finding that behavioral intentions did not predict behavioral change is in line with ample research demonstrating that individuals often fail to transform their intentions into action (Sheeran, 2002). Rather than behavioral intention, intrinsic motivation to perform the behavior turned out to be one of the most important predictors for behavioral change. The present study was the first to include the role of both behavioral intention and intrinsic motivation in predicting dietary intake. These results suggest that for changing actual behavior, it is essential that young adolescents are intrinsically motivated to eat fruits and vegetables or drink water. These findings are consistent with the self-determination perspective and add to the growing body of research that intrinsic motivation is the key to changing, improving, and maintaining a healthier lifestyle in the long term (Mata et al., 2009; Pelletier et al., 2004; Ryan et al., 2008; Silva et al., 2011; Teixeira et al., 2015).

The current study also demonstrated the importance of expanding the normative component of the theory of planned behavior. Findings revealed that only descriptive norms of parents predicted changes in young adolescents' water consumption. On the one hand, this finding is in line with the literature distinguishing between separate types of normative influences, given that descriptive norms were a stronger predictor than injunctive norms for water consumption (Cialdini et al., 1991; for review, see Jones & Robinson, 2017; Robinson et al., 2014). On the other hand, the current study also showed that it is essential to distinguish between the sources of normative influences. After all, the findings showed that parental norms were a more important predictor of water consumption than the

norms of friends. A possible explanation for the important role of parental norms in this study might be that, given the age of the participants, they were still living with their parents, resulting in daily exposure to the influence of their parents on their consumption behavior (Birch & Fisher, 1998; Patrick & Nicklas, 2005; Pearson et al., 2009).

Findings from this study indicate several directions for future research. Given the result that intrinsic motivation and parents were important predictors of behavioral change, the question arises as to which role parents play in the development of intrinsic motivation among young adolescents. The self-determination theory highlights the crucial role of parenting, which can either facilitate or undermine young adolescents' intrinsic motivation (Deci & Ryan, 1985; Vansteenkiste et al., 2004). From this perspective parents' daily behavior, which provides young adolescents with the opportunity to imitate the behavior, does provide not only information about the norms but also the chance to learn and develop the intrinsic motivation for the particular behavior (Matthies, Selge, & Klöckner, 2012). For example, one could expect that when young adolescents often see their parents drinking water, this would contribute to the development of their intrinsic motivation to drink water. It would be interesting for future research to examine the relation between parental social norms and the development of intrinsic motivation using longitudinal data. In addition, future research could also include a measure of the extent to which young adolescents engage in dietary intake because of pressure from their parents as the social component of the model (Birch et al., 2001).

This study has a number of strengths, including a relatively large sample and the use of sophisticated longitudinal SEM analyses. However, some limitations need to be acknowledged. First, the assessments of adolescents' fruit, vegetable, and water consumption were based on self-report. Although these measurements have usually been found reliable (Vereecken & Maes, 2003), one should keep in mind the potential overestimation of adolescents' dietary intake (Collins, Watson, & Burrows, 2010; Lally, Bartle, & Wardle, 2011). Second, the measures of

intrinsic motivation were adjusted to the age group and the various consumption behaviors, but were not validated here; however, they were based on validated studies (Ryan & Connell, 1989; Vansteenkiste et al., 2013), showed good reliability, and the age- and behavior-specific questions are expected to have increased their construct validity. Nevertheless, future research should confirm this assumption and validate the adjusted measures.

In conclusion, the findings of this study highlight the importance of young adolescents' intrinsic motivation for predicting changes in fruit, vegetable, and water consumption. Young adolescents who were intrinsically motivated to consume fruit, vegetables, and drink water were more likely to change their consumption behavior. In addition, the descriptive norms of parents predicted changes in young adolescents' water consumption. Young adolescents who perceived that their parents consumed water often were themselves more likely to drink water. A challenge for future research would be to examine how intrinsic motivation can be incorporated in interventions targeting fruit, vegetable, and water consumption. Intervention developers could test whether incorporating intrinsic motivation, (e.g., by creating an environment that supports the intrinsic motivation of targeted individuals by providing them with rationales for the behavior and supporting their need for autonomy), leads to increased consumption of fruit, vegetables, and water (Deci & Ryan, 1985; Sebire, Edwards, et al., 2016; Smit et al., 2016). In addition, further research could also examine how interventions can ensure that parents set a good example at home for their children regarding healthy dietary intake, given that the descriptive norms of parents could increase their children's fruit, vegetable, and water consumption (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008).

4

PROMOTING WATER CONSUMPTION AMONG CHILDREN: A THREE-ARM CLUSTER RANDOMIZED CONTROLLED TRIAL TESTING A SOCIAL NETWORK INTERVENTION

This chapter is published as:
Smit, C. R., de Leeuw, R. N., Bevelander, K. E., Burk, W. J., Buijs, L., van Woudenberg, T. J., & Buijzen, M. (2020). Promoting water consumption among children: A three-arm cluster randomized controlled trial testing a social network intervention. *Public Health Nutrition*, 1-30. https://doi.org/10.1017/S1368980020004802

ABSTRACT

The current study examined the effectiveness of a social network intervention to improve children's healthy drinking behaviors. A three-arm cluster randomized control trial design was used. In the social network intervention, a subset of children was selected and trained as 'influence agents' to promote water consumption–as an alternative to sugar-sweetened beverages–among their peers. In the active control condition, all children were simultaneously exposed to the benefits of water consumption. The control condition received no intervention. Four hundred and fifty-one children (M_{age} = 10.74, SD_{age} = .97; 50.8% girls) from 11 schools in the Netherlands were randomly assigned to either the social network intervention, active control condition, or control condition. Structural path models showed that children exposed to the social network intervention consumed .20 less sugar-sweetened beverage per day compared to those in the control condition (β = .25, p = .035). There was a trend showing that children exposed to the social network intervention consumed .17 less sugar-sweetened beverage per day than those in the active control condition (β = .20, p = .061). No differences were found between conditions for water consumption. However, the moderation effects of descriptive norms (β = -.12, p = .028) and injunctive norms (β = .11–.14, both p = .050) indicated that norms are more strongly linked to water consumption in the social network intervention condition compared to the active control and control conditions. These findings suggest that a social network intervention promoting healthy drinking behaviors may prevent children from consuming more sugar-sweetened beverage. Moreover, for water consumption, the prevailing social norms in the context play an important role in mitigating the effectiveness of the social network intervention.

BACKGROUND

The prevalence of overweight and obesity in children remains a major global health concern (WHO, 2020). The consumption of sugar-sweetened beverages (SSB) has been identified as a significant contributor to weight gain in children (Malik, Pan, Willett, & Hu, 2013). Reducing the consumption of SSB can be an effective strategy for the prevention of childhood overweight and obesity (Hu, 2013). In particular, promoting water consumption as an alternative to SSB seems to be a promising approach (Zheng, Allman-Farinelli, et al., 2015). Mass media campaigns are widely used in the public health sector to address excessive SSB consumption (Boles, Adams, Gredler, & Manhas, 2014; Farley et al., 2017; Jordan, Taylor Piotrowski, Bleakley, & Mallya, 2012). In these campaigns, large populations are simultaneously exposed to health messages in a rapid manner through various media channels (Wakefield et al., 2010). Unfortunately, with such campaigns, the overall average behavioral change occurs in only 8% of the population (Snyder et al., 2004). A possible reason for their limited effectiveness could be that these mass campaigns, among others, do not incorporate the strong influence of peers (Patrick & Nicklas, 2005; Salvy et al., Therefore, the current study investigated whether an approach that utilizes peer influence can be more effective in promoting healthy drinking behaviors among children.

State-of-the-art intervention studies promoting other health-related behaviors, such as fruit and vegetable consumption (Story et al., 2002), physical activity (Sebire et al., 2018), condom use (Kelly et al., 1991) and smoking cessation (Campbell et al., 2008; Valente et al., 2003), revealed that utilizing peer influence can be beneficial in promoting healthy behaviors. In these so-called 'social network interventions', the influence of peers is utilized by selecting a subset of children as influence agents to diffuse the target health message or behavior into the children's network (Valente, 2010, 2012). At the heart of this approach lies the diffusion of innovation theory (Rogers, 1962), which describes how new ideas and behaviors are spread among members of a social network. During the diffusion process, some individuals (i.e., influence agents) have more influence on the behavior of

others due to their unique position in the network (Rogers, 2010). Deploying these influence agents as advocates of the target behavior (e.g., as role models) can accelerate the diffusion process and behavior change in social networks (Valente & Davis, 1999).

There is promising evidence from recent pilot studies that children's drinking behavior can be improved with such a social network-based approach (Franken, Smit, & Buijzen, 2018; Smit et al., 2016). In these studies, the influence agents were trained to encourage water consumption—as an alternative to SSB—among their peers. In both studies, an increase in children's water consumption, as well as a decrease in their SSB consumption, was found (Franken et al., 2018; Smit et al., 2016). However, these studies only investigated the effectiveness of the social network intervention by comparing it to a control condition. Thus, the question remains whether this promising social network-based approach is actually more effective than an active control condition based on the principles of mass media campaigns.

Moreover, social network interventions utilizing peer influence are assumed to tap into normative behaviors. Research has shown that children do not like to deviate from the group norms and experience a strong need for acceptance, which prompts them to conform to the normative behavior of their peers (Higgs, 2015; Jones & Robinson, 2017; Stok et al., 2016). The literature distinguishes between two types of social norms, namely descriptive and injunctive norms (Cialdini et al., 1991; Reno et al., 1993). Descriptive norms refer to the perception of how most people behave (Reno et al., 1993). For healthy drinking, for example, this would imply that children perceive that their peers drink a certain amount of water. Injunctive norms refer to the perception of what others consider appropriate (Reno et al., 1993). For example, an injunctive norm for healthy drinking would be that children perceive approval of their peers when they drink a certain amount of water. Several studies have shown that both type of norms affect children's dietary behaviors with regard to the type and amount of food they perceive their peers to consume or approve of (Higgs, Liu, Collins, & Thomas, 2019; Jones & Robinson, 2017; Larimer, Turner, Mallett, & Geisner, 2004; Mollen, Rimal, Ruiter, &

Kok, 2013). Therefore, it is conceivable that the success of peer-led interventions may depend on the prevailing social norms in the target network.

As yet, only one social network intervention included the moderating role of social norms, finding that the children's injunctive norms interacted with the success of the social network intervention promoting water consumption (Franken et al., 2018). That is, children who initially perceived high injunctive peer norms to consume water reported an increase in their water consumption (Franken et al., 2018). In this case, the promoted behavior in this intervention was in accordance with the norm children perceived beforehand. It is, therefore, plausible that social network interventions are more successful for children who perceive that the prevailing norm is in accordance with the promoted behavior. Nevertheless, it is also plausible that social network interventions are more effective for children who initially perceived a discrepancy between the prevailing norm and the promoted behavior. When the desired behavior is promoted in the intervention, it could be that they want to live up to the promoted norm and adjust their behavior accordingly. Thus far, there has been only one study that showed that the success of social network interventions depends on the prevailing injunctive norms and none on descriptive norms. Given the sparse research attention so far, this study explored the moderating role of both descriptive and injunctive norms.

Thus, the current study tested whether an intervention utilizing peer influence was more effective than an active control condition—based on the principles of mass media campaigns—and a control without any intervention. We also investigated the moderating role of the prevailing social norms in the context. We hypothesized that children who were exposed to the social network intervention promoting water consumption as an alternative to SSB would report consuming more water post-intervention than those in the active control condition (H1a) and control condition (H1b). We also expected that children who were exposed to the social network intervention would report consuming less SSB post-intervention than those in the active control condition (H2a) and control condition (H2b). Finally, we explored the moderating role of descriptive and injunctive norms on the effectiveness of the social network intervention.

METHODS

Design

The study involved a three-arm cluster randomized controlled trial with schools as the unit of randomization. The schools were randomly assigned to either the (1) existing social network intervention (called *Share H_2O*), (2) active control condition or (3) control condition by a random allocation algorithm. In the social network intervention, children were exposed to peers from their own classroom who were identified and trained as influence agents to promote water consumption as an alternative to SSB consumption. The active control condition was based on the principles of mass media campaigns and, therefore, consisted of exposing all children simultaneously to a presentation on the benefits of water consumption. The required sample size was based on the previous pilot study (Smit et al., 2016) where a small effect of the social network intervention was found with 210 children with a social network intervention condition and control condition. This number was multiplied with 1.5 to add the third condition (i.e., active control) in the current study, resulting in a minimum number of 315 children across the three groups. In order to take non-response in the active consent procedure into account, a larger number of children were recruited.

Procedure

The study took place from February to June 2018 and consisted of three assessments: baseline (February–March 2018; T1), immediately after the start of the intervention (April–May 2018; T2) and during a follow-up four weeks later (June–July 2018; T3). At each assessment, children received a smartphone with a pre-installed research application and an activity-tracking bracelet for seven days (Bevelander et al., 2018; MyMovez, 2017). Via the research application, children received questionnaires and were also able to chat and to share pictures and short videos with peers. At T1, children completed drinking-related measures and sociometric nominations. Identical measures were assessed at T2 and T3. To assess whether children were aware of the actual purpose of the study, they were asked at T3 to describe what they believed to be the purpose of the study. None

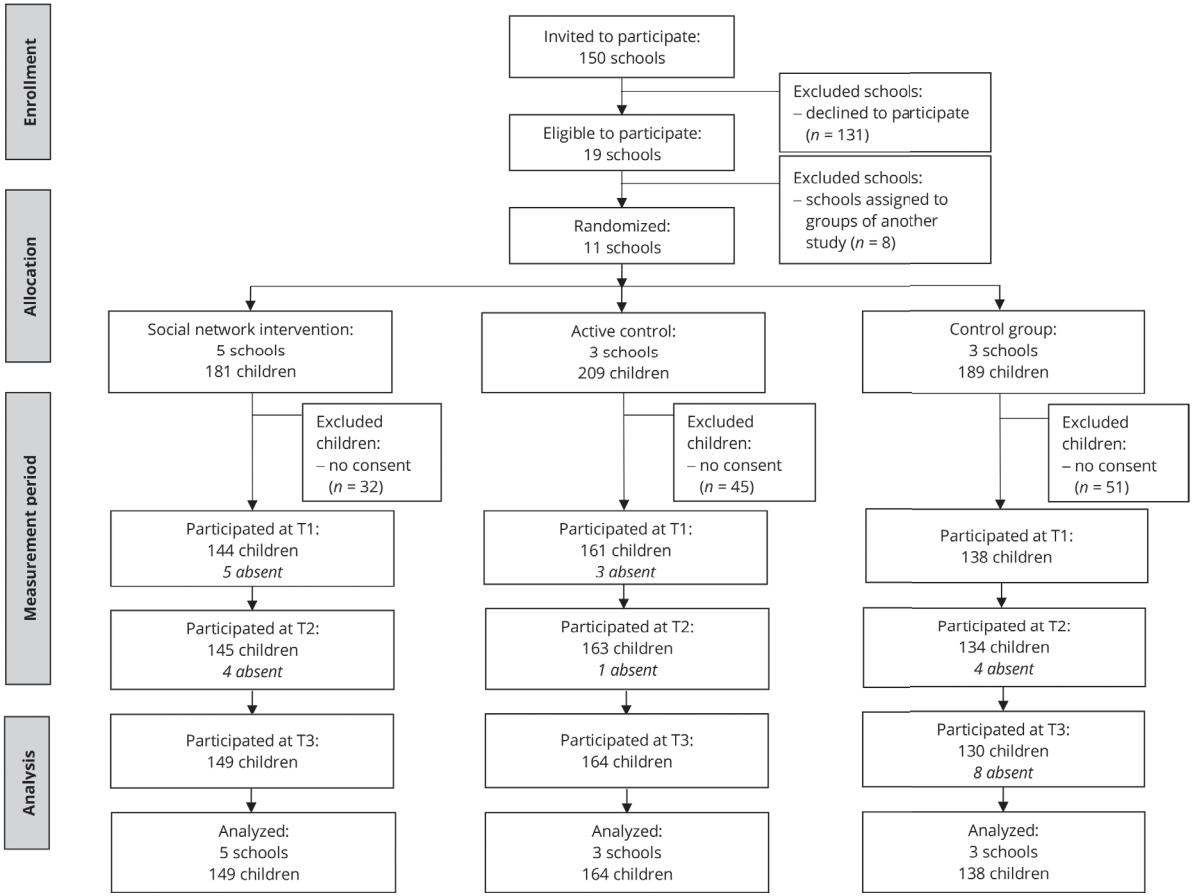
of the children indicated that the goal of the study was for influence agents to promote water consumption.

Participants

The study was part of the second data collection phase of the *MyMovez* research program (Bevelander et al., 2018). Participants were recruited through their school. All schools following a regular education program were eligible for participation. As shown in Figure 4.1, 150 urban and suburban schools in the Netherlands were invited to participate in the second phase of the *MyMovez* research program. Twenty-one schools expressed interest in participating; however, two of these schools were unable to participate due to not receiving enough active consents from caregivers as well as children themselves (< 60% in each classroom (Marks, Babcock, Cillessen, & Crick, 2013). Of these 19 remaining schools, eight schools were assigned to three other conditions from the *MyMovez* research program that focused on promoting physical activity (van Woudenberg et al., 2020).

The current study consisted of the 11 schools that were randomly assigned to one of the three conditions that focused on children's drinking behaviors. Five schools were assigned to the social network intervention, three to the active control condition and three to the control condition. These schools were located in different areas in the Netherlands, with considerable geographical distance between the conditions (social network intervention vs. active control schools ranged from 36 to 203 km; social network intervention vs. control schools ranged from 30 to 203 km; active control vs. control schools ranged from 20 km to 197 km). Therefore, the risk of between-group contamination was negligible. Out of the 579 children in these 11 schools, a total of 128 (22%) caretakers did not provide consent for their child to participate. Thus, the sample consisted of 451 children (50.8% girls) between 9 and 14 years old (M = 10.74 years; SD = .97). Of these children, 149 (47.7% girls) were allocated to the social network intervention, 164 (56.1% girls) to the active control condition and 138 (47.8% girls) to the control condition (see Figure 4.1 for the flow diagram of study participants). The number of participating children was 443 at T1, 442 at T2 and 443 at T3.

Figure 4.1 CONSORT flow diagram of study participants



The Social Network Intervention *Share H_2O*

The social network intervention involved selecting and training a subset of children from each classroom as influence agents to promote water consumption—as an alternative to SSB—among their peers. The content of the social network intervention training was nearly the same as the pilot version of the *Share H_2O* intervention (Smit et al., 2016). However, for this study, we aimed to improve the training content by incorporating more principles of the self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2017) to increase the intrinsic motivation of the peers, in addition to that of the influence agents. Another difference was that in the current study, research assistants were trained to deliver the training to the influence agents, instead of the primary investigator. In general, the purpose of the training was twofold. The first aim was to motivate the influence agents by providing them with the benefits of drinking water—as an alternative for SSB—and encourage them with self-generated arguments to drink more water. The second aim was to support the influence agents in motivating their peers by providing them with the skills to promote water consumption and identifying potential barriers.

Compared to the pilot study, we placed more emphasis in the training on how the influence agents could create an intrinsic motivating climate for their peers while promoting water consumption. Recent research has shown that being intrinsically motivated is an important predictor for positively altering children's water drinking behaviors (Smit et al., 2018). According to self-determination theory, being autonomy supportive enhances intrinsic motivation (Deci & Ryan, 1985; Ryan & Deci, 2000; Soenens & Vansteenkiste, 2010). To this end, possible barriers that the influence agents might encounter while promoting drinking water and how they could overcome these whiles being autonomy supportive were discussed, for example, by taking in consideration the perspective of their peers or providing them with meaningful rationales (Soenens & Vansteenkiste, 2010). One week after the training, a follow-up session took place to provide visible support, resolve any issues experienced by the influence agents in their role and refresh the information discussed in the training.

The Active Control Condition

In the active control condition, children simultaneously received knowledge about the benefits of drinking water—as an alternative for SSB—through a half-hour classroom presentation. This presentation was delivered by research assistants, and the benefits were the same as those discussed in the training of the influence agents. At the time of the presentation, children who had not received consent from their caretakers to participate in the study went to another classroom with the teacher.

Measures

Peer Nominations

To identify the influence agents in each classroom, the children were asked to nominate at least one peer whom they "wanted to be like", "regarded as good leaders", "went to for advice" (Smit et al., 2016; Starkey et al., 2009) and "talked to about what they drink" (Rogers, 2010). For the selection of the influence agents, only same-classroom peer nominations were included. To ensure sex balance in relation to the composition of the classrooms, 15% of boys and 15% of girls in the social network intervention with the most nominations on all items together were selected and trained as influence agents (Smit et al., 2016; Starkey et al., 2009). On average, five children (*SD* = 1.06) per participating classroom in the social network intervention schools were trained as influence agents. This resulted in a total of 37 influence agents from eight classrooms.

Water Consumption

Children indicated on three different days (i.e., every other day during each data collection wave) how much water they drunk the day before (Bevelander et al., 2018; Smit et al., 2018, 2016). Response options ranged from 0 = 'zero glasses per day' to 7 = 'seven or more glasses per day'. An illustration was used to instruct the children that one glass also meant one can, bottle, or package of approximately 200 ml. A total score for water consumption was constructed by averaging the children's reported consumption over the three days (Cronbach's α ranged from .65 to .78).

Sugar-Sweetened Beverage Consumption

Children indicated on three different days (i.e., every other day during each data collection wave) how much sweetened fruit juice, lemonade (based on sugar syrup), soda, energy and sports drinks they drunk the day before (Bevelander et al., 2018; Smit et al., 2016). Response options ranged from 0 = 'zero glasses per day' to 7 = 'seven or more glasses per day'. The same illustration as with water consumption was used to instruct the children about the portion size. A total score for SSB consumption was constructed by averaging the children's reported consumption on the five different consumption items over the three days (Cronbach's α ranged from .66 to .80).

Descriptive Norms

Children's perception of the prevalence of their classmates' behavior was assessed with the following item: "How often do your classmates drink water?" (Bevelander et al., 2018; Smit et al., 2018). Response options ranged from 1 = 'never' to 6 = 'always'.

Injunctive Norms

Children's perception of what their classmates considered appropriate behavior was assessed with the following item: "Do you experience that your classmates think you should drink water?" (Bevelander et al., 2018; Smit et al., 2018). Response options ranged from 1 = 'no, certainly not' to 6 = 'yes, certainly'.

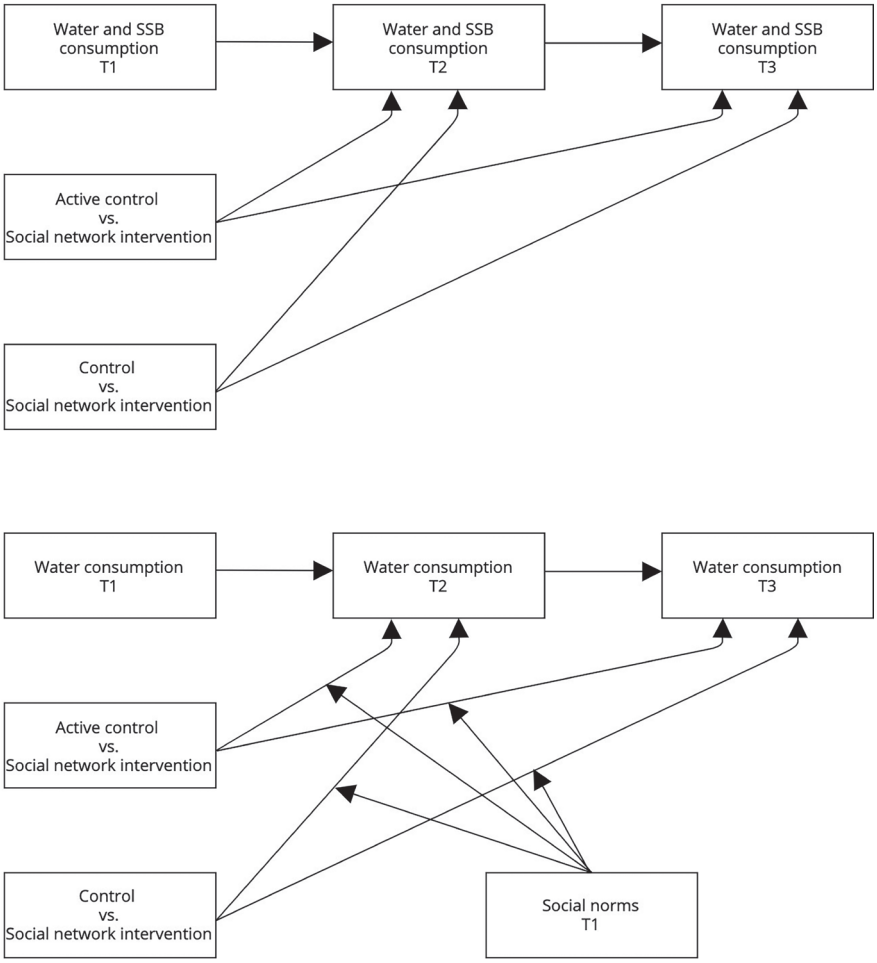
Strategy of Analyses

Descriptive statistics were calculated to examine the means and standard deviations of all study variables. Subsequently, randomization checks were performed using one-way ANOVA to test whether there were initial mean-level differences between the conditions for the outcome variables (i.e., water and SSB consumption). Pearson's correlations were performed for the variables of interest to determine which variable had to be controlled for in the main analyses.

For the main analyses, three structural path models were tested using Mplus 7.2 (Muthén & Muthén, 2012). The first model tested mean-level differences between conditions on water and SSB consumption after the intervention (T2 and T3), adjusting for consumption prior to the intervention (T1; see Figure 4.2a); the second model examined whether descriptive norms moderated the mean-level differences between conditions on subsequent water consumption and the third model examined whether injunctive norms moderated the mean-level differences between conditions on subsequent water consumption (see Figure 4.2b). In all models, condition was specified as two binary dummy variables with social network intervention as reference category (coded as 0). In the last two models, the social norm variables were centered prior to creating the interaction terms involving social norms and differences between conditions.

The parameters in the models were estimated applying (full-information) maximum-likelihood estimation with robust standard errors (MLR in Mplus) to account for missing values and potential deviations from multivariate normality. Additionally, the models were adjusted for clustering of the sample—children were 'nested' in classrooms—using the Mplus procedure TYPE = COMPLEX, with classroom as the cluster variable. This procedure results in standard errors that are adjusted to account for non-independence within classrooms. The fit of the path models was assessed with the following good fit indices: root mean square error of approximation (RMSEA, with a cut-off value of $< .08$ and p-close $> .05$), comparative fit index (CFI, with a cut-off value of $> .90$) and normed χ^2 (χ^2/df, with a cut-off value of < 3.0; Hu & Bentler, 1999; Kline, 2011). In the structural path analyses, the unstandardized regression coefficient (b) provides the estimated mean-level difference between conditions on consumption behaviors following the intervention, adjusted for baseline consumption behaviors. For models yielding significant interaction effects, simple slope analyses (Aiken, West, & Reno, 1991) were used to examine the regression coefficient of the condition–consumption behavior relationship across two levels of the moderator (low social norms: -1 *SD*; high social norms: +1 *SD*).

Figure 4.2 The conceptual models for testing the differences between conditions on water and SSB consumption



Note. [a]Model for testing the mean-level differences between conditions on water and SSB consumption after the intervention (T2 and T3), adjusting for previous consumption; [b]model for testing whether social norms moderated the mean-level differences between conditions on subsequent water consumption (T2 and T3), adjusted for previous consumption; moderation was tested separately for descriptive and injunctive norms; sex was included as a covariate in the first model.

RESULTS

Preliminary Analyses

Descriptive Statistics and Randomization Check

Descriptive statistics showed that on average children consumed 2.99 (*SD* = 1.70) glasses of water and .57 (*SD* = .58) glasses of SSB a day at baseline (T1). The means and standard deviations for all study variables across the conditions are summarized in Table 4.1.

Table 4.1 Means and standard deviations for all study variables across the conditions per assessment

	SNI (*n* = 149)		**Active Control (*n* = 164)**		**Control (*n* = 138)**	
	M	***SD***	***M***	***SD***	***M***	***SD***
Water consumption T1	3.03	1.89	3.12	1.58	2.79	1.62
Water consumption T2	3.12	1.99	3.12	1.66	2.76	1.97
Water consumption T3	3.07	2.07	2.29	1.87	2.62	2.00
SSB consumption T1[a]	.67	.72	.49	.47	.55	.58
SSB consumption T2	.64	.79	.45	.42	.73	1.06
SSB consumption T3	.61	.69	.57	.59	.81	1.21
Descriptive norms T1	3.62	1.03	3.55	1.04	3.74	1.11
Injunctive norms T1	3.69	1.65	3.73	1.65	2.97	1.77

Note. SNI, social network intervention; *M,* mean; *SD*, standard deviation; T1, Time 1; T2, Time 2; T3, Time 3; [a]the three conditions differed significantly on this variable ($p < .05$).

To check whether there were initial mean-level differences between the three conditions on the outcome variables (i.e., water and SSB consumption), one-way ANOVA were conducted. The analyses yielded statistically significant differences at baseline (T1) between conditions for SSB, $F(2,435) = 3.57$, $p = .029$, but not for water consumption, $F(2,435) = 1.38$, $p = .252$ (see Table 4.1). This indicated that the randomization was not successful for SSB consumption; it is therefore essential to account for these initial differences between conditions to avoid interpreting regression to the mean effects (i.e., groups that have low mean scores are more likely to increase; Barnett, Van Der Pols, & Dobson, 2005). To account for these initial differences, we included baseline consumption behavior (T1) as a predictor of consumption behavior at T2 and T3 in the structural path models.

Correlations Among Variables

Pearson's correlations were computed to examine the bivariate relationship between the variables of interest (see Table 4.2). Children's water consumption was positively related to descriptive norms and not related to injunctive norms. Children's SSB consumption was only negatively related to sex, indicating that boys drank more SSB than girls. Therefore, we included sex as a covariate in the model testing the mean-level differences between conditions on SSB consumption.

Table 4.2 Correlations among all study variables (*N* = 451)

	1	2	3	4	5	6	7	8
1- Sex[a]								
2- Water consumption T1	.01							
3- Water consumption T2	.03	.48***						
4- Water consumption T3	.01	.39***	.56***					
5- SSB consumption T1	-.16**	.01	-.05	-.06				
6- SSB consumption T2	-.17**	-.04	.03	.01	.46***			
7- SSB consumption T3	-.09	-.06	.03	-.03	.32***	.55***		
8- Descriptive norms T1	.02	.12*	.10*	.08	-.00	-.09	.03	
9- Injunctive norms T1	.02	.02	.01	-.02	.03	-.02	.00	.09

Note. T1, Time 1; T2, Time 2; T3, Time 3; [a]0 = boy and 1 = girl;* $p < .05$, ** $p < .01$, *** $p < .001$.

Main Analyses

Condition Differences on Changes in Water and Sugar Sweetened Beverage Consumption

The first structural path model examined whether children exposed to the social network intervention increased their water and decreased SSB consumption compared to those in the active control condition (H1a and H2a) and control condition (H1b and H2b). This model demonstrated a good fit to the observed data, RMSEA = .04, CFI = .97 and normed $\chi^2 = 1.58$. Table 4.3 presents the results of this model.

Table 4.3 Results for the model testing mean-level differences between conditions on water and SSB consumption after the intervention (*N* = 451)

	Water consumption					SSB consumption				
	b	***SE***	***β***	***p***	**CI**	***b***	***SE***	***β***	***p***	**CI**
Regression paths										
Active control [1] vs. SNI [0]—Behavior T2	-.02	.18	-.01	.936	-0.20 – 0.19	-.03	.06	-.04	.633	-0.18 – 0.11
Control [1] vs. SNI [0]—Behavior T2	-.17	.31	-.09	.589	-0.43 – 0.24	.20	.10	.25	.035	0.02 – 0.48
Active control [1] vs. SNI [0]—Behavior T3	-.31	.25	-.16	.217	-0.40 – 0.09	.17	.10	.20	.061	-0.01 – 0.40
Control [1] vs. SNI [0]—Behavior T3	-.20	.20	-.10	.308	-0.29 – 0.09	.19	.13	.21	.131	-0.06 – 0.49
Stability paths										
Behavior T1—Behavior T2	.51	.06	.47	<.001	0.36 – 0.58	.51	.06	.49	<.001	0.32 – 0.66
Behavior T2—Behavior T3	.62	.05	.58	<.001	0.5 – 0.64	.62	.05	.64	<.001	0.46 – 0.82
Control variables										
Sex[a]—Behavior T2	-.00	.16	-.00	.977	-0.08 – 0.08	-.00	.16	-.08	.119	-0.18 – 0.02
Sex[a]—Behavior T3	.02	.24	.01	.923	-0.11 – 0.12	.02	.24	-.03	.431	-0.10 – 0.04

Note. b, unstandardized regression coefficient estimating the mean-level difference between conditions, adjusted for previous consumption; *SE*, standard error; *β*, standardized regression coefficient; CI, 95% confidence interval; SNI, social network intervention; T1, Time 1; T2, Time 2; T3, Time 3; [a]0 = boy, 1 = girl; numbers in parentheses represent the binary dummy coded values; SNI is the reference category in the model.

The model showed that there was a significant mean-level difference between the social network intervention and control condition on SSB consumption at T2, adjusting for baseline SSB consumption (*b* = .20, *SE* = .10, *β* = .25, *p* = .035, 95% CI [0.02, 0.48]). This indicated that, immediately after the intervention, children exposed to the social network intervention consumed an average of .20 glasses less SSB per day than those in the control condition, adjusting for SSB consumption prior to the intervention. At T3, there was a marginally significant mean-level difference between the social network intervention and active control condition on SSB consumption, adjusted for baseline SSB consumption (*b* = .17, *SE* = .10, *β* = .20, *p* = .061, 95% CI [-0.01, 0.40]). This indicated that there was a trend showing that, four weeks after the start of the intervention, children exposed to the social network intervention consumed an average of .17 glasses less SSB per day than children in the active control condition (adjusting for SSB consumption at T1). For

water consumption, there were no statistically significant differences between the three conditions.

Moderating Effects of Norms on Water Consumption

Descriptive Norms

The second structural path model examined the potential moderating role of descriptive norms on the effectiveness of the social network intervention. This model showed a good fit to the observed data, RMSEA = .02, CFI = .99 and normed χ^2 = 1.16. At T2, the main effect of descriptive norms emerged as statistically significant, but this effect was qualified by a significant interaction between descriptive norms and the difference among the social network intervention and control condition on water consumption, adjusting for water consumption at T1 (*b* = -.38, *SE* = .16, β = -.12, *p* = .028, 95% CI [0.23, -0.01]; see Table 4.4). To interpret this interaction, we conducted simple slope analysis.

Figure 4.3a presents the significant interaction, with water consumption at T2 (adjusted for T1) on the *y*-axis, conditions on the *x*-axis and separate regression lines for participants with high (+1 *SD*) and low (-1 *SD*) descriptive norms. This figure indicates that there was a positive relation between conditions and water consumption at T2 (adjusted for T1) for high descriptive norms (*b* = -.60, *SE* = .42, *p* = .154) and a negative relation for low descriptive norms (*b* = .25, *SE* = .29, *p* = .381), but neither slope significantly differed from zero. Thus, there is some evidence to suggest that children reporting higher descriptive norms consumed more water in the social network intervention and less water in the control condition compared to those with lower norms. While the simple slopes differed in valence, this interpretation is made cautiously considering the lack of statistically significant simple slopes.

Table 4.4 Results for the model testing descriptive norms as a moderator of the mean-level differences between conditions on water consumption (*N* = 451)

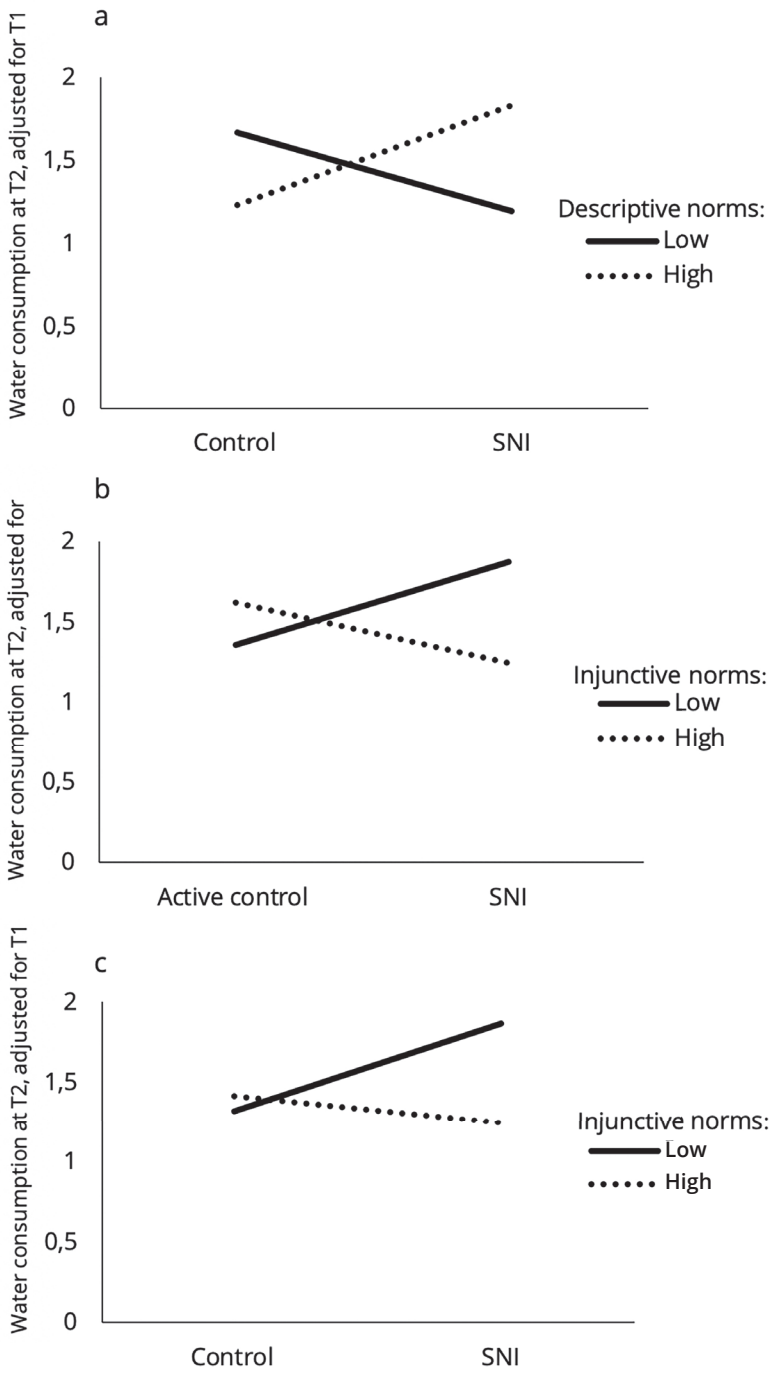
	Water consumption				
	b	***SE***	***β***	***p***	**CI**
Regression paths					
Active control [1] vs. SNI [0]—Behavior T2	-.00	.19	-.00	.982	-0.20 – 0.20
Control [1] vs. SNI [0]—Behavior T2	-.18	.32	-.10	.584	-0.43 – 0.24
Descriptive norms T1—Behavior T2	.23	.11	.13	.048	0.00 – 0.25
Active control [1] vs. SNI [0] X Descriptive norms T1—Behavior T2	-.13	.13	- .04	.308	-0.13 – 0.04
Control [1] vs. SNI [0] X Descriptive norms T1—Behavior T2	-.38	.16	-.12	.028	-0.23 – -0.01
Active control [1] vs. SNI [0]—Behavior T3	-.31	.24	-.16	.195	-0.40 – 0.08
Control [1] vs. SNI [0]—Behavior T3	-.22	.19	-.11	.249	-0.30 – 0.08
Descriptive norms T1—Behavior T3	-.04	.21	-.02	.844	-0.24 – 0.19
Active control [1] vs. SNI [0] X Descriptive norms T1—Behavior T3	.06	.27	.02	.830	-0.14 – 0.18
Control [1] vs. SNI [0] X Descriptive norms T1—Behavior T3	.23	.28	.07	.399	-0.09 – 0.23
Stability paths					
Behavior T1—Behavior T2	.49	.06	.45	<.001	0.34 – 0.56
Behavior T2—Behavior T3	.62	.05	.58	<.001	0.50 – 0.65

Note. b, unstandardized regression coefficient estimating the mean-level difference between conditions, adjusted for previous consumption; *SE*, standard error; *β*, standardized regression coefficient; CI = 95% confidence interval; SNI, social network intervention; T1, Time 1; T2, Time 2; T3, Time 3; numbers in parentheses represent the binary dummy coded values; SNI is the reference category in the model.

Injunctive Norms

The last structural path model examined the potential moderating role of injunctive norms on the effectiveness of the social network intervention. This model showed a good fit to the observed data, RMSEA = .06, CFI = .99 and normed χ^2 = 2.65. At T2, the main effect of injunctive norms emerged as statistically significant, but this effect was qualified by a significant interaction effect between injunctive norms and the difference among the social network and active control conditions on water consumption, adjusting for water consumption at T1 (*b* = .26, *SE* = .12, *β* = .14, *p* = .050, 95% CI [-0.00, 0.28]). There was also a significant interaction effect between injunctive norms and the difference among the social network intervention and control conditions on water consumption, adjusting for water consumption at T1 (*b* = .21, *SE* = .11, *β* = .11, *p* = .050, 95% CI [0.00, -0.22]; see Table 4.5).

Figure 4.3 The interactions between descriptive norms (a) or injunctive norms (c and b) and conditions on water consumption at T2, adjusted for T1 consumption



To examine these significant interactions, we conducted simple slope analysis. Figures 4.3b and 4.3c present the significant interaction, with water consumption at T2 (adjusted for T1) on the *y*-axis, conditions on the *x*-axis and separate regression lines for participants with high (+1 *SD*) and low (-1 *SD*) injunctive norms. Figure 4.3b indicates that there was a positive relation between conditions and water consumption at T2 (adjusted for T1) for low injunctive norms (*b* = -.52, *SE* = .26, *p* = .044) and a negative relation for high injunctive norms (*b* = .37, *SE* = .29, *p* = .206). Figure 4.3c also indicates that there was a positive relation between conditions and water consumption at T2 (adjusted for T1) for low injunctive norms (*b* = -.54, *SE* = .28, *p* = .056) and a negative relation for high injunctive norms (and *b* = .16, *SE* = .44, *p* = .710), but neither slope significantly differed from zero. Thus, these interactions collectively suggest that children reporting lower injunctive norms consumed more water in the social network intervention condition and less water in the active control condition and control condition compared to those with higher norms.

Table 4.5 Results for the model testing injunctive norms as a moderator of the mean-level differences between conditions on water consumption (*N* = 451)

	Water consumption				
	b	***SE***	***β***	***p***	**CI**
Regression paths					
Active control [1] vs. SNI [0]—Behavior T2	-.07	.18	- .02	.685	-0.11 – 0.07
Control [1] vs. SNI [0]—Behavior T2	-.19	.33	- .05	.564	-0.21 – 0.11
Injunctive norms T1—Behavior T2	-.18	.09	- .17	.039	-0.33 – 0.01
Active control [1] vs. SNI [0] X Injunctive norms T1—Behavior T2	.26	.12	.14	.050	-0.00 – 0.28
Control [1] vs. SNI [0] X Injunctive norms T1—Behavior T2	.21	.11	.11	.050	0.00 – 0.22
Active control [1] vs. SNI [0]—Behavior T3	-.27	.24	- .07	.267	-0.18 – 0.05
Control [1] vs. SNI [0]—Behavior T3	-.23	.21	- .05	.277	-0.15 – 0.04
Injunctive norms T1—Behavior T3	.06	.04	.05	.122	-0.01 – 0.03
Active control vs. SNI [0] X Injunctive norms T1—Behavior T3	-.13	.09	- .06	.163	-0.15 – 0.03
Control [1] vs. SNI [0] X Injunctive norms T1—Behavior T3	-.13	.08	- .07	.095	-0.14 – 0.01
Stability paths					
Behavior T1—Behavior T2	.51	.06	.47	<.001	0.36 – 0.58
Behavior T2—Behavior T3	.62	.05	.57	<.001	0.50 – 0.65

Note. b, unstandardized regression coefficient estimating the mean-level difference between conditions, adjusted for previous consumption; *SE*, standard error; *β*, standardized regression coefficient; CI = 95% confidence interval; SNI, social network intervention; T1, Time 1; T2, Time 2; T3, Time 3; numbers in parentheses represent the binary dummy coded values; SNI is the reference category in the model.

DISCUSSION

The *Share H_2O* social network intervention aimed to positively alter children's healthy drinking behaviors by exposing them to influence agents from their own classroom who promoted water consumption as an alternative to SSB. The current study tested the effectiveness of this approach by comparing it to an active control condition—based on the principles of mass media campaigns—and a control condition without any intervention. Furthermore, the moderating role of the prevailing social norms in the context was tested. The findings showed that children exposed to the *Share H_2O* social network intervention consumed less SSB afterwards compared to children in the active control condition and control condition. No differences between the conditions were found for water consumption. However, the effectiveness of the social network intervention on water consumption seems to depend on the prevailing social norms. More specifically, children exposed to the social network intervention with initially higher perceived descriptive norms and lower perceived injunctive norms consumed more water afterwards compared to those in the active control condition and the control condition.

Our findings regarding the effect on SSB consumption showed that after the intervention, children exposed to the social network intervention remained stable in their SSB consumption, while the children in the active control condition and control condition consumed more SSB. This finding is different compared to our previous pilot studies in which children exposed to the social network intervention decreased in their SSB consumption over time (Franken et al., 2018; Smit et al., 2016). A possible explanation may lie in seasonal differences. In the current study, the baseline measurement took place during the winter, while the intervention took place during the spring, which resulted in much weather difference between the two measurements. In the previous pilot studies (Franken et al., 2018; Smit et al., 2016), both measurements took place in the same season and the weather was therefore more stable. Thus, it may be that the social network intervention with influence agents spreading the message or behavior in their peer group prevented children from turning to SSB during warm weather. However, future research is

needed to explore this possibility, along with replication studies over the years to shed more light on this reasoning.

Nevertheless, it is in line with our expectations that when peers communicate about the benefits of drinking water—as an alternative for SSB—it could be an effective strategy to prevent children from consuming SSB. This effect was found on the short term and compared to the control condition without an intervention. However, the question remains why the difference between the social network intervention and the active control is not so pronounced. It could be that the benefits of drinking water presented to the children in the active control condition were convincing enough for the children, even when the research assistants communicated them. These benefits were formulated based on short-term outcomes (e.g., "Drinking water helps you concentrate better at school") as they are generally considered to be more motivating than long-term consequences (Chandran & Menon, 2004). It is therefore possible that the framing of these messages itself was already strong and convincing, irrespective of the sender. However, the findings suggest that when these benefits are communicated by peers, the effects are less short-lived, given that a marginal difference was found between the social network intervention and the active control condition at T3. Nevertheless, more research is needed to further investigate this. Altogether, the findings of this study suggest that the *Share* H_2O social network intervention can be fruitful for schools specifically targeting SSB consumption.

Contrary to our expectations and a previous pilot study (Smit et al., 2016), we did not find that the social network intervention was effective in increasing water consumption in general. One reason for this finding could be that the general opinion about water drinking has changed in the past years. Our pilot study was conducted four years ago, and meanwhile, a great deal of (media) attention has been paid to the health benefits of drinking water, including the environmental consequences of drinking SSB instead of water (i.e., plastic soup). For example, by the national organization Jongeren Op Gezond Gewicht [Youth at a Healthy Weight] (AD, 2016; JOGG, 2020) that focuses on changing the water drinking norms

in schools. The plastic soup also received a lot of (inter)national attention, for example, from the World Wildlife Fund, and even a famous national children's choir released a song called "Plastic Soep" [Plastic Soup] in 2017, which became very popular (Alessi, Di Carlo, Campogianni, Tangerine, & Pietrobelli, 2018; Seleky, 2017). This (media) attention for water consumption has probably inspired some children and parents to drink more water in recent years. For this group, the content of the *Share* H_2O intervention—which mainly focuses on the benefits of drinking water—could have been less or perhaps even not inspiring at all. It is therefore essential that future research focuses on updating the content in order to better respond to the current consumption behavior, norm and knowledge of the target children. This can be achieved, for example, by involving these children in the development of the content (i.e., co-design; Visser, Stappers, van der Lugt, & Sanders, 2005) and thus taking into account their vision, which can increase intrinsic motivation in health interventions (Gillison et al., 2019). Recent research has shown that intrinsic motivation is a crucial predictor of changing children's water consumption (Smit et al., 2018).

In line with our expectations, we indeed found that the prevailing social norms concerning water drinking moderated the effectiveness of the social network intervention on water consumption. First, the social network intervention was found to be more effective among children who already perceived that their classmates were drinking water before the intervention started (i.e., higher perceived descriptive norm). Probably, the higher prevalence of water drinking peers in their environment led these children to consider water drinking as a normal and socially acceptable behavior. When water drinking was promoted by peers they wanted to be like or went to for advice, this intervention 'message' was congruent with what these children were already perceiving in their environment. This may have resulted in it being perceived as a familiar message, making it easier to adjust their behavior accordingly. In contrast, for children with initially lower perceived descriptive norms, it may be that the discrepancy between the 'message' (i.e., drink more water) and what they perceived in their environment may have been too large to bridge, leading to lower behavioral change. This

reasoning is consistent with the contextual-congruence model which suggests that higher levels of congruence between values, beliefs and behaviors across children's social environments facilitate the internalization process (Spera & Matto, 2007). This may also play a role between the social environment and intervention messages, as the lack of incongruent talk about the target behavior in the social environment is a facilitative condition of media effects (Southwell & Yzer, 2007).

Second, we found that children who initially perceived lower injunctive peer norm consumed more water after being exposed to the social network intervention, while children who perceived higher levels of injunctive norm in their environment did not change their water consumption. More specifically, the intervention was not successful among children who perceived that their classmates thought that they should drink water. Previous research has shown that higher levels of injunctive norm can be perceived as a coercive pressure from others to conduct the target behavior (Cialdini et al., 1991). Thus, it could be that in a context without this perceived peer pressure to drink water (i.e., low levels of injunctive norms), children may become more motivated (Ryan & Deci, 2000) to adopt their behavior in accordance with the water promoting message in the social network intervention. In contrast, in a context where they beforehand do perceive high levels of peer pressure to drink water (i.e., high levels of injunctive norms), they could become less motivated to adopt their behavior in accordance with the message.

It is important to underline that the current study yielded a conflicting pattern compared to the previous pilot study examining the moderating role of injunctive norms in social network interventions (Franken et al., 2018). More specifically, the study of Franken et al. (2018) found that children who initially perceived higher injunctive peer norms were more likely to change their behavior. A possible reason for this conflicting pattern could be that the Franken et al. (2018) study was conducted on a Caribbean island involving cultural differences regarding social norms and energy intake-related behaviors (Kumanyika, 2008). Further research is therefore needed to determine how exactly the prevailing social norms in the context interacts with the effectiveness of social network intervention.

Additionally, the next step for future research is also to examine whether and how social network interventions change the perceived social norms of children, which in turn may cause the intervention effect. Previous research showed that changes in students' perceptions of descriptive drinking norms mediated the effect of brief motivational interventions targeting alcohol consumption (Carey, Henson, Carey, & Maisto, 2010).

Limitations and Future Research

This study had a number of strengths, including a relatively large sample, multiple time points and a theoretically well-founded intervention. However, some limitations need to be addressed in interpreting the findings. First, the assessment of children's drinking behaviors was based on self-report. Although self-reported intake is usually considered reliable (Vereecken & Maes, 2003), one should keep in mind that there is potential for under-reporting or over-reporting of these behaviors. Future studies could try to replicate our findings using additional and more direct measurements of beverage consumption, such as observations at school or flow meters attached to the schools' water fountains (Muckelbauer et al., 2009). Second, we only measured the effect immediately after the intervention and four weeks later. Although our results indicated some improvements in children's drinking behaviors at least four weeks after the intervention, the next step is to replicate this study and include a follow-up assessment one year later to examine the effect on the longer term (Campbell et al., 2008).

Third, the current study solely focused upon stimulating peer influence and did not consider other important social influences. Despite the fact that peers are increasingly important during childhood (Salvy et al., 2012), parents continue to exert influence (Pearson et al., 2009). Recent research has shown that parental norms also play an important role in changing children's healthy drinking behaviors (Smit et al., 2018). Hence, a conceivable approach to improve the social network intervention could be to not merely incorporate peer influence but additionally motivate parents to set a good example at home for their children with regard to water drinking (Story et al., 2008).

Conclusion and Implications

The findings of this study support the growing body of social network intervention research demonstrating that incorporating the strong influences of peers seems to strengthen interventions promoting healthy behaviors (Franken et al., 2018; Sebire et al., 2018; Smit et al., 2016). Selecting influencing agents and motivating them to drink (more) water and to spread this message and behavior among their peers could prevent children from consuming more SSB. In addition, the study emphasizes that the success of the *Share H_2O* social network intervention on water consumption depends on the prevailing peer norms in the context in which it is implemented. The current research focused on children's drinking behavior, but this social network approach, which makes use of the strong influence of peers (Salvy et al., 2012) and focuses on increasing the motivation of children (Smit et al., 2018), might also have fruitful effects for other consumption behaviors, such as increasing the intake of healthy snacks.

5

PROMOTING WATER CONSUMPTION AMONG DUTCH CHILDREN: AN EVALUATION OF THE SOCIAL NETWORK INTERVENTION SHARE H_2O

This chapter is published as:
Smit, C. R., de Leeuw, R. N., Bevelander, K. E., Burk, W. J., van Woudenberg, T. J., Buijs, L., & Buijzen, M. (2021). Promoting water consumption among Dutch children: An evaluation of the social network intervention Share H2O. *BMC Public Health,* 21, 1-15.
https://doi.org/10.1186/s12889-021-10161-9

ABSTRACT

There is a need to develop and improve interventions promoting healthy drinking behaviors among children. A promising method could be to stimulate peer influence within children's social networks. In the *Share H_2O* social network intervention, peer influence was utilized by selecting a subset of influential children and training them as 'influence agents' to promote water consumption—as an alternative to sugar-sweetened beverages. Previous research has mainly focused on the process of selecting influence agents. However, the process of motivating influence agents to promote the behavior has hardly received any research attention. Therefore, in the *Share H_2O* social network intervention, this motivation process was emphasized and grounded in the self-determination theory. This study evaluated the implementation of the *Share H_2O* social network intervention, focusing on whether and how applying self-determination theory-based techniques can motivate the influence agents and, indirectly, their peers. The study included data collected in the Netherlands from both the influence agents (n = 37) and the peers (n = 112) in the classroom networks of the influence agents. Self-reported measurements assessed the influence agents' enjoyment of the training, duration and perceived autonomy support during the training, and changes in their intrinsic motivation and water consumption before and after the start of the intervention. Changes in the peers' intrinsic motivation, perceived social support, and social norms were measured before and after the start of the intervention. Results showed that the influence agents enjoyed the training, considered the duration to be adequate, and perceived the training to be autonomy supportive. There was an increase in the influence agents' intrinsic motivation to drink water and their actual water consumption. Providing personal meaningful rationales seemed to have motivated the influence agents. The intrinsic motivation and perceived descriptive norm of the peers remained stable. The peers reported an increase in their perceived social support and injunctive norm concerning water drinking after the intervention. Influence agents appeared to mainly use face-to-face strategies, such as modeling, talking to peers, and providing social support to promote the behavior. The current findings provided preliminary evidence for the

promising effects of using self-determination theory-based techniques in social network interventions to motivate influence agents and, indirectly, their peers.

BACKGROUND

The prevalence of childhood overweight and obesity has increased at an alarming rate worldwide (WHO, 2020). The increasing consumption of sugar-sweetened beverages (SSBs) has been identified as a major contributor to these rising levels (Luger et al., 2017). The majority of children (61%) consume at least one SSBs on a given day with an average of 132.5 kcal/day (Bleich, Vercammen, Koma, & Li, 2018). Reducing the consumption of SSBs has proven to be an effective strategy to decrease weight gain in children (Hu, 2013). In particular, replacing the consumption of SSBs with water seems to be a promising approach (Zheng, Rangan, et al., 2015). Unfortunately, data from several countries suggest that children's daily water consumption is below recommended levels (Drewnowski et al., 2013; RIVM, 2019; Sui, Zheng, Zhang, & Rangan, 2016; Vieux et al., 2017). There is therefore a need for interventions aimed at promoting water consumption among children and thus reducing their SSBs consumption. However, recent evidence identifies that previous interventions have only had small positive effects on the water and SSB consumption of children (Vargas-Garcia et al., 2017).

A promising method for interventions may be to incorporate the influence of the social environment in order to promote water consumption among children. There is sufficient evidence that the social environment strongly influences the consumption behavior of children (Cruwys et al., 2015; Herman, 2015; Higgs, 2015; Patrick & Nicklas, 2005). As children grow older, their susceptibility to peers increases, peaking during early adolescence (Steinberg & Monahan, 2007). Extensive systematic reviews have therefore also shown that peers play an important role in children's food choice and intake (Salvy & Bowker, 2013; Salvy et al., 2012). For example, peers can establish a social guideline (i.e., social norm) on food choice and intake which can be followed by others (Stok et al., 2016). In social modelling studies, children also appear to directly adjust their intake to that of their table companions (Cruwys et al., 2015). Children also tend to consume more

food when they are in the presence of several peers (Herman et al., 2003). Despite this important role of peers, until recently peers have been relatively overlooked in many interventions aimed at the consumption of water and SSBs for children (Vargas-Garcia et al., 2017). An intervention approach that utilizes peer influence to address health-related behaviors is the so-called "social network interventions" (Valente, 2012, 2015).

In recent years, there has been a growing interest in the use of social network interventions in the field of public health (Bell et al., 2017; Campbell et al., 2008; Sebire et al., 2018; Smit et al., 2016; van Woudenberg et al., 2020). At the heart of this approach lies the diffusion of innovations theory, which conceptualizes how individuals can act as change agents to informally diffuse new beliefs and behaviors in a social network (Rogers, 2010). Based on this premise, interventionists select a subset of individuals as influence agents to initiate the diffusion of the target health behaviors in their social network (Valente & Davis, 1999). Accordingly, in the social network intervention called *Share H_2O*, children were selected as influence agents and trained to promote water consumption—as an alternative to sugar-sweetened beverages (SSBs)—among their peers (Franken et al., 2018; Smit et al., 2016, 2020). As reported elsewhere (Smit et al., 2020), the *Share H_2O* intervention was effective in increasing water drinking and reducing SSBs, with the effectiveness on water drinking depending on the prevailing social norms in the classrooms. In particular, children with higher perceived descriptive norms and lower perceived injunctive norms reported an increase in their water drinking. The study reported here evaluates the implementation of the *Share H_2O* social network intervention.

Previous research has mainly focused on the process of selecting the most successful influence agents by investigating the best peer nomination questions and selection criteria to identify them. However, despite the underlying premise of social network interventions that the selected influence agents diffuse the desired behavior in their network, the process of motivating the influence agents to do so has hardly received any research attention (Sebire et al., 2018; Smit et al., 2016). To fill this gap, the current study focuses on the process of motivating the influence

agents in social network interventions to diffuse the target behavior in their social network. The evaluation followed the theoretical framework that guided the design of the *Share H_2O* training in order to motivate the selected influence agents and, indirectly, their peers.

The *Share H_2O* training was grounded in self-determination theory, a prominent theory of human motivation (Deci & Ryan, 1985; Ryan & Deci, 2017). Research on self-determination theory has amply demonstrated that intrinsic motivation, the most autonomous kind of motivation, plays a central role in facilitating health behavioral change and its maintenance (Ng et al., 2012). Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable (Ryan & Deci, 2000, 2017). Individuals who are intrinsically motivated are more likely to adopt and maintain health-related behaviors (Hagger et al., 2014), such as drinking more water (Smit et al., 2018). According to self-determination theory, being intrinsically motivated depends on the satisfaction of three basic psychological needs: autonomy (feeling that one is responsible and has choice), competence (feeling that one is capable and effective), and relatedness (feeling respected and close to others; Deci & Ryan, 2000; Ryan & Deci, 2017). These three needs can be satisfied by creating an autonomy-supportive climate, involving self-determination theory-based techniques, such as providing meaningful rationales, choice, and support, and encouraging self-initiative (Deci & Ryan, 2000; Vansteenkiste et al., 2004). Therefore, in order to optimally motivate the influence agents and, indirectly, their peers, the *Share H_2O* training was developed to foster an autonomy-supportive climate. This was done by facilitating their basic psychological needs by applying self-determination theory-based techniques in the training.

Research Aims of the Current Study

The focus of this study is to evaluate the implementation of the *Share H_2O* intervention, in particular whether and how applying self-determination theory-based techniques can motivate the influence agents and, indirectly, their peers. We used reports of both the influence agents and the peers in the classroom networks of the influence agents. Based on the framework guiding the *Share*

H_2O intervention, we addressed three specific research aims. The first aim was to evaluate the influence agents' general experiences with the training by assessing their ratings of their enjoyment of the training, the duration, and perceived autonomy support during the training. The second aim was to assess whether the training motivated the influence agents to drink more water themselves by examining changes in the influence agents' intrinsic motivation and water consumption before and after the start of the intervention. The third aim was to examine whether the influence agents were successful in motivating their peers by investigating changes in the peers' intrinsic motivation, perceived social support, and perceived social norms before and after the start of the intervention.

METHODS

Design

This study was integrated into the *Share H_2O* intervention effectiveness study (Smit et al., 2020), which was part of the second data collection phase of the *MyMovez* research program (see Bevelander et al., 2018) for a detailed description of the *MyMovez* program). The study reported on data collected from both the selected influence agents and their peers. The required sample size for the *Share H_2O* effectiveness study was based on the previous pilot study (Smit et al., 2016), in which a small effect on water and SSB consumption was found with 210 children in the intervention and control condition. To calculate the sample for the effectiveness study (Smit et al., 2020), this number was multiplied by 1.5 to add the third group (i.e., the active control), resulting in a minimum number of 315 children across the three groups. Ethical approval was obtained from the Ethics Committee of the Faculty of Social Sciences at Radboud University (ECSW2014–100614-222) and the ethical review board from the European Research Council (617253). The design of the *Share H_2O* social network intervention was preregistered at the Netherlands Trial Register (NL6905).

Procedure

Both suburban and urban schools throughout the Netherlands were invited to participate via an email to the school principal. Only primary or secondary schools following a regular education program and with classes between the 4th and 7th grade (i.e., students aged 9 to 13 years) were invited to participate in the *MyMovez* research program. The project focused on this age group because it is important that children learn healthy intake behaviors at an early age since the increase in overweight and obesity is the steepest around the ages of 16 to 20 years (CBS, 2020b) and intake habits and preferences developed in childhood can persist into adulthood (Lake, Mathers, Rugg-Gunn, & Adamson, 2006). After obtaining written permission from the school principals, an information letter was distributed to the children and their parents. In addition, pitches were delivered in school classes to recruit participants. Given the age of the participants (< 16 years), written informed consent was obtained from a parent or legal guardian as well as the children themselves. Subsequently, the participating schools were randomly assigned to one of the five conditions of the *MyMovez* program (see Smit et al., 2020; van Woudenberg et al., 2020 for a detailed description of the conditions). The current study sample included the five (sub) urban primary schools (i.e., eight classes from grades 4–6) assigned to the condition exposed to the *Share* H_2O social network intervention.

For the overall *Share* H_2O social network intervention, data were collected at baseline (T1; February–March 2018) immediately after the start of the intervention (T2; April–May 2018), and during a follow-up 4 weeks later (T3; June–July 2018). The evaluation measurements of the current study were collected at T1 and T2 only. At each assessment, children received a smartphone with a preinstalled research application and a wrist-worn accelerometer for seven days (Bevelander et al., 2018; MyMovez, 2017). Via the research application, children received daily questionnaires and were able to use a social media platform *(Social Buzz)*, create a personalized avatar, and play a puzzle game. In the *Social Buzz*, children could chat, share pictures, and short videos with their peers through the social media platform integrated in the research application.

The *Share H_2O* Social Network Intervention

Briefly, the social network intervention comprised of (1) identifying and selecting the influence agents and (2) training the influence agents, followed by an informal follow-up a week later. The influence agents were identified through peer nominations. Children nominated the peers on four sociometric nomination questions ("Whom do you ask for advice?"; "Who in your classroom are leaders or take the lead often?"; "Whom do you want to be like?"; and "With whom do you talk about what you drink?"; Starkey et al., 2009). The selection criteria for the influence agents were those from each participating classroom who were most often nominated by their peers on all items combined. To ensure gender balance in relation to the composition of the classrooms, 15% of the boys and 15% of the girls with the most nominations were selected as influence agents. This resulted in an average of five children (range 3–6 children; $SD = 1.06$) per participating classroom being trained as influence agents (Smit et al., 2020).

The influence agents' training lasted 1 hour and took place at school, led by research assistants who worked in pairs. The research assistants were trained (≈ 8 h) by skilled researchers who had ample expertise in conducting research with children at schools and with an autonomy-supportive approach to working with children. The research assistants all had a background in pedagogical sciences, in which they studied the development of children and adolescents. To ensure that each training session in the intervention classroom was conducted in a similar fashion, the principal trainer accompanied each research assistant on their first training session and provided them with a guideline to facilitate the delivery of the training. This guideline contained information about *Share H_2O* in general, the theoretical principles of the intervention approach and training, and a detailed script to implement each technique in the training. In addition, the research assistants were in constant contact with the principal trainer, and interim evaluations were performed after each training was given.

As described above, the *Share H_2O* training was grounded in self-determination theory and refined with input from children and research experts, and thereafter

extensively tested in two pilot studies (Franken et al., 2018; Smit et al., 2016). One week after the training, a half-hour follow-up training session took place at school. This follow-up session provided the research assistants with the opportunity to offer visible support to the influence agents, resolve any problems experienced by the influence agents, and refresh the core topics discussed in the initial training. In the following sections, we describe how the training implemented self-determination theory-based techniques to motivate influence agents to drink more water and support them in motivating their peers to drink water (a detailed overview of all training materials is available upon request).

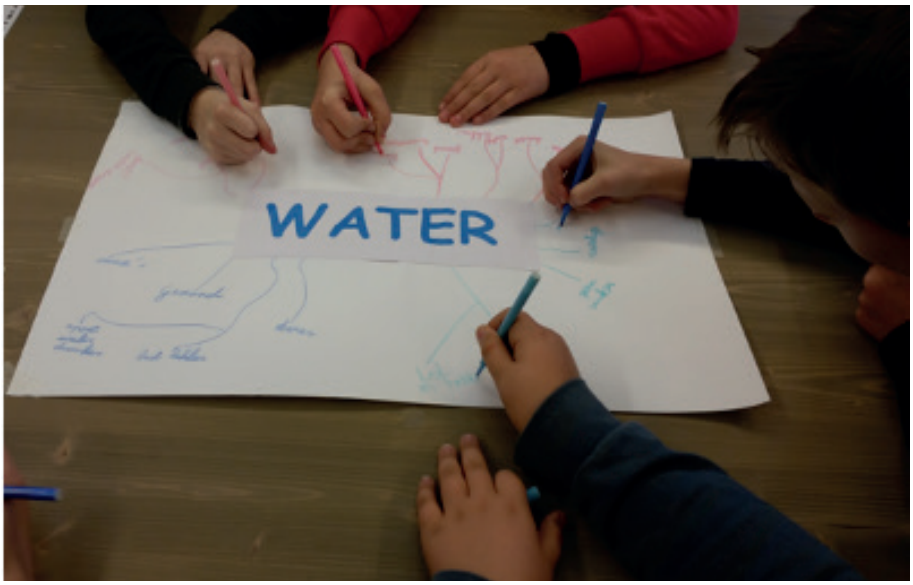
Motivating Influence Agents to Drink More Water Themselves

The first part of the *Share H_2O* training focused on motivating the influence agents to increase their own water consumption. To achieve this, we implemented two self-determination theory-based techniques in the training: providing meaningful rationales for drinking water and prompting the influence agents to self-initiate the target behavior (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020).

The technique of providing meaningful rationales for drinking water highlights and reinforces personally meaningful and valuable rationales that could form the basis for intrinsic motivation (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020). Research has shown that even with a boring task, meaningful rationales can lead to internalization (Deci, Eghrari, Patrick, & Leone, 1994). This technique was implemented in the training by discussing the benefits of drinking water. First, all influence agents were asked to brainstorm about the benefits by working together on a word web (see Figure 5.1). This allowed them to learn meaningful and valuable benefits from their peers—to which children at this age are highly susceptible (Steinberg & Monahan, 2007). Subsequently, the trainers supplemented these benefits through an interactive presentation which included a range of health (e.g., "Water does not contain sugar" and "Water is the best thirst quencher") and environmental benefits (e.g., "Drinking water is good for the animals and the nature") for drinking water. The presentation also included quiz questions in which the influence agents learned, for example, that the recommendation is to drink

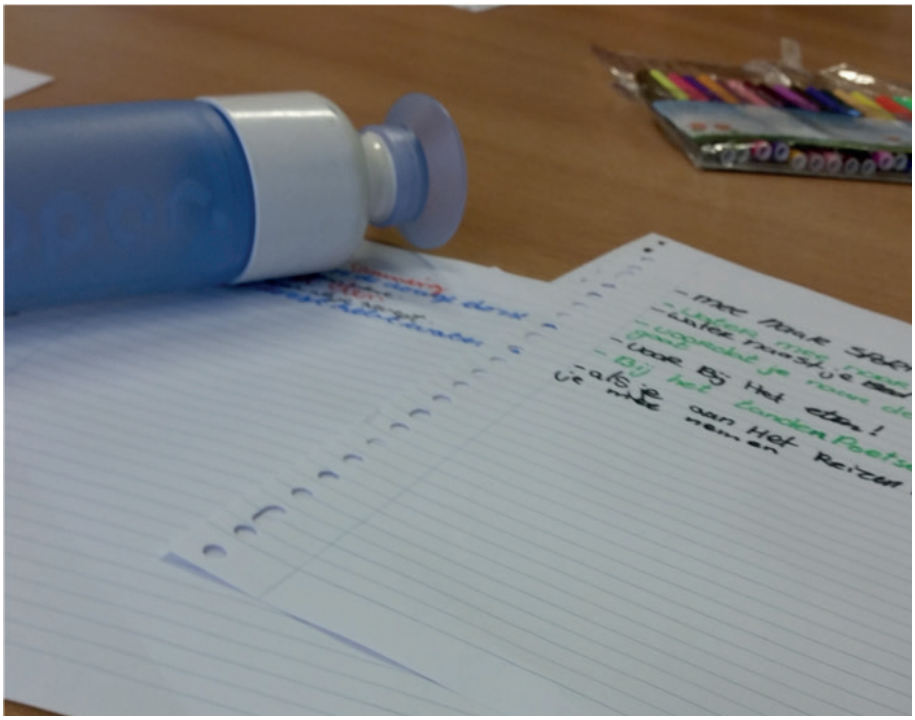
1.5 l of water per day. All the benefits in this presentation were based on short-term outcomes (e.g., "Drinking water makes your skin beautiful" and "Drinking water ensures that you can concentrate better") because these are considered more motivating than long-term consequences (Chandran & Menon, 2004).

Figure 5.1 Influence agents working together on a word web about the benefits of drinking water



The technique of encouraging self-initiation of drinking water involves prompting individuals to initiate the target behavior themselves, which provides them with an opportunity to learn and develop the associated skills, all of which support their intrinsic motivation (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020). Hence, after discussing the benefits of drinking water in the training, the influence agents were encouraged to drink more water themselves through the use of self-persuasion (Aronson, 1999). This involved placing them in a situation where they had to persuade themselves to drink more water (Miller & Wozniak, 2001; Mussweiler & Neumann, 2000). More specifically, the influence agents were asked to generate their own arguments that indicate how they could drink more water in order to persuade themselves to do so (see Figure 5.2).

Figure 5.2 An example of a sheet containing the self-generated arguments of the influence agents



Supporting Influence Agents in Motivating Their Peers

The second part of the training focused on supporting the influence agents in their task of motivating their peers to drink more water. For this purpose, two self-determination theory-based techniques were used in the training: allowing the influence agents to choose how to motivate their peers and providing them with the skills to do so (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020).

The technique of providing choice promotes personal input and ownership of the behavioral change (Teixeira et al., 2020), which facilitates individuals' need for autonomy (Deci & Ryan, 2000; Gillison et al., 2019; Teixeira et al., 2020). Ample research suggests that individuals are more intrinsically motivated to perform the target behavior when provided with choices (Patall, Cooper, & Robinson, 2008; Prusak, Treasure, Darst, & Pangrazi, 2004; Ward, Wilkinson, Graser, & Prusak,

2008). In order to support the influence agents in motivating their peers, influence agents were encouraged in the training to choose how exactly they wished to motivate their peers. Therefore, the influence agents were asked to think and decide for themselves concerning how to promote water drinking and were facilitated in sharing their devised ideas with their peers.

The technique of providing the influence agents with skills on how to motivate peers included providing information on how to perform the target behavior and promoting the feeling of competence in the behavior (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020). Therefore, in the training, through possible scenarios, it was discussed how and when they could promote water drinking among their peers to provide them the skills to do so. A possible water-promoting strategy discussed in these scenarios was setting a good example by drinking water themselves. Research has shown that children tend to model the intake behavior of their peers (Cruwys et al., 2015). In addition, it was also discussed that they could promote water drinking through informal communication (Rogers, 2010), for example, by talking about water drinking at school or sending messages and short videos about it (see Figure 5.3) on *Social Buzz* to their peers. Subsequently, they brainstormed together about potential barriers they might encounter and how to overcome them. Finally, the influence agents were continuously supported by the researchers in motivating their peers, which corresponds to their need for relatedness (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020).

Measurements

The sections below describe the evaluation measurements used to collect quantitative (close-ended) and qualitative (open-ended) data from both the influence agents and the peers. Table 5.1 presents an overview of the quantitative measurements.

Figure 5.3 Screenshots of the short videos which the influence agents spread among their peers

Note. These are screenshots of the short videos about the benefits of drinking water which the influence agents were able to spread among their peers. The first screenshot is from a scene where a child talks about the environmental benefit of drinking water. In this scene, the child explained that if more people drink water, less plastic is made in the factories because you can drink water from the tap. This allows less plastic to end up in the plastic soup in the North Pacific Ocean. The short videos also included other benefits of drinking water, including that water contains no sugar and has zero calories. All these benefits correspond to the ones discussed in the presentation during the training and were suggested by the children themselves.

General Experiences with the Training

The influence agents' enjoyment of the training was assessed using a 4-point scale ranging from 1 = 'no, not at all' to 4 = 'yes, a lot', adapted from the level of enjoyment measure reported by Sebire et al. (2019), and with open-ended responses about which parts of the training they enjoyed the most and least. Their experiences with the duration of the training were assessed using a 5-point scale ranging from 1 = 'too short' to 5 = 'too long'. The extent to which the influence agents' perceived autonomy support during the training was assessed using the short form (six-items; see Table 5.1) of the Learning Climate Questionnaire (Black & Deci, 2000), with response options ranging from 1 = 'no, not at all' to 4 = 'yes, a lot'.

Motivating Influence Agents to Drink More Water Themselves

To evaluate whether the training motivated the influence agents, we assessed their intrinsic motivation and their water and SSB consumption. The influence agents' intrinsic motivation to drink water was measured at T1 and T2, using three items (see Table 5.1) adapted from a scale based on exercising (Markland & Tobin, 2004; Smit et al., 2018), with a 6-point response scale ranging from 1 = 'no, certainly not' to 6 = 'yes, certainly'. A total score for intrinsic motivation was constructed by averaging the three items. To assess water consumption at T1 and T2, the influence agents indicated on three different days (i.e., every other day during each assessment) on an 8-point scale ranging from 0 = 'zero glasses per day' to 7 = 'seven or more glasses per day' how much water they had drunk the day before. A total score for water consumption was constructed by averaging the influence agents' reported consumption over the three days. To assess the influence agents' SSB consumption they had to indicate on three different days (i.e., every other day during each assessment) how much sweetened fruit juice, lemonade (based on sugar syrup), soda, energy, and sports drinks they had drunk the day before (Bevelander et al., 2018; Smit et al., 2016). The same response scale as with water consumption was used. To assist them in recognizing each of these types of beverages, examples of frequently consumed beverages were included for each item. A total score for SSB consumption was constructed by averaging the influence agents' reported consumption on these five items over the three days. The influence agents also provided responses to several open-ended questions concerning their experiences with the training, which were used to evaluate the self-determination theory-based techniques that were implemented to motivate them.

Supporting Influence Agents in Motivating Their Peers to Drink Water

To evaluate whether the training supported the influence agents in optimally motivating their peers, we assessed their peers' intrinsic motivation, perceived social support, and social norms regarding water drinking. The intrinsic motivation of the peers was measured at T1 and T2 with the same three items (see Table

5.1) as with the influence agents (Markland & Tobin, 2004; Smit et al., 2018). A total score for the peers' intrinsic motivation was constructed by averaging the three items, which demonstrated adequate internal consistency (Cronbach's α_{T1} = .83; Cronbach's α_{T2} = .87). Their perceived social support to drink water was measured at T1 and T2, using four items derived from a broader questionnaire on healthy behaviors (Kiernan et al., 2012), each rated on a 6-point scale ranging from 1 = 'never' to 6 = 'always'. A total score for perceived social support was constructed by averaging the four items, which demonstrated adequate internal consistency (Cronbach's α_{T1} = .79; Cronbach's α_{T2} = .86). The peers' perceived social norm was assessed at T1 and T2, based on their beliefs about how often one's peers drink water (i.e., descriptive norm; response options ranged from 1 = 'never' to 6 = 'always') and their beliefs about the approval of one's peer regarding drinking water (i.e., injunctive norm; response options ranged from 1 = 'no, certainly not' to 6 = 'yes, certainly'; Smit et al., 2018).

To evaluate the self-determination theory-based techniques that were implemented in the training to support the influence agents in motivating their peers, we measured on a 6-point scale (ranging from 1 = 'never' to 6 = 'always') whether the influence agents applied the water-promoting strategies discussed in the training: (1) drinking water themselves, (2) talking about water at school or home, (3) talking and (4) forwarding short videos about water on a social media platform (*Social Buzz*). The influence agents also provided responses to several open-ended questions concerning the strategies they implemented to motivate their peers to drink more water and their experiences therein.

Statistical Analyses

All data were analyzed using SPSS version 25 (SPSS, Inc., Chicago, IL, US). Significance was set at $p < .05$. For the close-ended (quantitative) data related to the first and third research aim, we computed both means (*M*) and standard deviations (*SD*) for the general experience measurements (i.e., influence agents' enjoyment and perceived autonomy support) and water-promoting strategies, as well as the percentage (%) of influence agents with positive (score of 3 or

higher) versus negative responses (score of 2 or lower) on these measurements. To analyze the quantitative data associated with the second and third aim, a series of paired sample *t*-tests were conducted to examine changes before and after the training in the influence agents' intrinsic motivation, and SSB and water consumption (second aim); and their peers' intrinsic motivation, perceived social support, and perceived social norms (third aim). It should be noted that although the data fail to meet the assumptions of normality, the paired sample *t*-test was nevertheless chosen over the customary Wilcoxon signed-rank (nonparametric) test due to the findings supporting its application in small samples involving non-normal distributions, and/or ordinal data (Meek, Ozgur, & Dunning, 2007). Table 5.2 presents the descriptive statistics of these quantitative measurements.

A content analysis was performed on the open-ended (qualitative) data related to the research goals. First, the primary researcher openly coded the open-ended responses to compile the categories, and afterwards, a second researcher coded the responses using the compiled categories. The responses of the influence agents related to their experiences with the training were classified based on the techniques implemented in the training. The influence agents' responses concerning how they motivated their peers were classified based on whether or not they had set a good example themselves (i.e., modelling; Cruwys et al., 2015), talked about water and its benefits (Rogers, 2010), and/or had offered social support (Kiernan et al., 2012). The Krippendorff's alpha test was used to estimate the interrater reliability between the two coders (Hayes & Krippendorff, 2007). The interrater reliability ranged from acceptable to good (Krippendorff's alpha ranged between $\alpha = .77$ and $\alpha = 1.00$). Finally, the percentages of influence agents in the compiled categories were reported. Additional analyses (i.e., Pearson's correlations) were performed to explore the effect of the training on the changes in intrinsic motivation, social support, and perceived social norms for different demographic variables of the peers (i.e., sex, grade level, and family affluence). The interindividual change score between the two assessments of the measurements were included as a change variable in the correlation analyses.

RESULTS

Demographic Characteristics

The sample of the current study consisted of 37 influence agents and 112 peers in the classroom networks of these influence agents. There were on average five influence agents per intervention class, aged between 9 and 13 years (M = 10.95, SD = .94). Their peers were between 9 and 14 years of age (M = 10.84, SD = 1.04). The majority of the influence agents and their peers came from high-affluence families (71.4% of influence agents and 69.4% of peers; Boyce, Torsheim, Currie, & Zambon, 2006)

General Experiences with the Training

The majority (84%) of the influence agents responded that they had enjoyed the training (scoring ≥3; see Table 5.2). Only 9% of the influence agents made a negative remark about the training; they indicated that they found the plastic soup (i.e., the environmental impact of drinking SSBs compared to tap water) sad and found it difficult to accept that they should persuade others. Most of the influence agents (84%; see Table 5.2) indicated that the training duration was adequate; that is, they thought that it was neither too short nor too long. Only 3% of the influence agents indicated that the training was too short. Almost all (97%; see Table 5.2) influence agents perceived the training as being autonomy supportive. The separate items of the perceived autonomy-support measure revealed that the influence agents experienced that the trainers had made efforts to provide choice, to encourage them to ask questions, to listen and understand them, and to show confidence in their ability (percentages ranging from 68 to 84% of the influence agents). This indicates that the influence agents experienced support for autonomy, competence, and relatedness during the training.

Table 5.1 Quantitative evaluation measures of the influence agents and their peers at T1 and/or T2

Measure name	Item(s)	Response options	Data sample	Time point
Enjoyment of the training	Did you like the training related to drinking water?	No, not at all No, not really Yes, a little bit Yes, a lot	Influence agents	T2
Duration of the training	What did you think of the duration of the training related to drinking water?	Too short Short Neither too short nor too long Long Too long	Influence agents	T2
Perceived autonomy support	I had the feeling that the researcher gave me choices. I felt understood by the researcher. The researcher showed that she had confidence in me to stimulate water drinking. The researcher encouraged me to ask questions. The researchers listened to how I wanted to stimulate water drinking. The researcher tried to understand my ideas before she herself came up with other ideas.	No, not at all No, not really Yes, a little bit Yes, a lot	Influence agents	T2
Intrinsic motivation	I drink water because... ... I like it ... I enjoy it ... I think it is pleasant	No, certainly not No, I do not think so No, possibly not Yes, possibly Yes, I think so Yes, certainly	Influence agents and peers	T1 and T2
Water consumption	How many glasses of water did you drink yesterday?	Zero glasses per day One glass per day Two glasses per day Three glasses per day Four glasses per day Five glasses per day Six glasses per day Seven or more glasses per day	Influence agents	T1 and T2

SSB consumption	How many glasses of sweetened fruit juice did you drink yesterday? How many glasses of lemonade made of sugar syrup and water did you drink yesterday? How many glasses of soda did you drink yesterday? How many glasses of energy drink did you drink yesterday? How many glasses of sport drink did you drink yesterday?	Zero glasses per day One glass per day Two glasses per day Three glasses per day Four glasses per day Five glasses per day Six glasses per day Seven or more glasses per day	Influence agents	T1 and T2
Perceived social support	How often do your peers... ... complement you on drinking water? ... participate in drinking water with you? ... remind you to drink water? ... offer to drink water with you?	Never Rarely Sometimes Often Very often Always	Peers	T1 and T2
Descriptive norms	How often do your classmates drink water?	Never Rarely Sometimes Often Very often Always	Peers	T1 and T2
Injunctive norms	Do you experience that your classmates think you should drink water?	No, certainly not No, I do not think so No, possibly not Yes, possibly Yes, I think so Yes, certainly	Peers	T1 and T2
Water-promoting strategies	How often did you drink water when your classmates were with you? How often did you talk with your classmates about drinking water at school or home? How often did you talk with your classmates about drinking water on the social media platform (*Social Buzz*)? How often did you send videos about water drinking to your classmates on the social media platform (*Social Buzz*)?	Never Rarely Sometimes Often Very often Always	Influence agents	T2

Note. T1 = baseline; T2 = immediately after the start of the intervention.

Motivating Influence Agents to Drink More Water Themselves

Regarding the training process of motivating the influence agents, the influence agents on average reported significantly higher intrinsic motivation to drink water after the training as compared to before the training, $t(26) = -2.31$, $p = .029$ (see Table 5.2), with 74% of the influence agents showing an increase. In addition to higher intrinsic motivation, the influence agents also reported drinking marginally significantly more water after the training compared to before the training, $t(26) = -1.89$, $p = .070$ (see Table 5.2), with 67% showing an increase. The influence agents did not drink significantly fewer SSBs after the training as compared to before the training, $t(26) = .88$, $p = .385$ (see Table 5.2); however, about half (52%) of the influence agents did show a decrease.

The open-ended responses of the influence agents suggest that the technique of providing meaningful rationales motivated the influence agents to drink more water themselves. Specifically, most (47%) of the influence agents indicated that the word web in combination with the interactive presentation—in which the meaningful rationales to drink water were discussed—were the most enjoyable aspects of the training:

> *"I liked the presentation the most [about the training]."*
>
> Girl, 10 years old

> *"I liked the most [about the training] that you can get handsome for free from drinking water and that you can get beautiful teeth."*
>
> Boy, 12 years old

> *"The interactive presentation, for example, guessing how many sugar cubes there are in a 250 ml coca cola can."*
>
> Boy, 10 years old

Table 5.2 Descriptive statistics of the evaluation measures of the influence agents and their peers

	T1			T2	
	M (SD)	**Range**	**% (*n*)**	***M (SD)***	**Range**
General experiences with the training					
Enjoyment of the training	3.66 (.55)	1–4	84% (31)		
Duration of the training	3.09 (.59)	1–5	84% (27)		
Perceived autonomy-support	3.54 (.38)	1–4	97% (30)		
Motivating influence agents to drink more water themselves					
Intrinsic motivation	4.48 (1.71)	1–6		4.93 (1.20)[a]	1.5– 6
Water consumption	2.82 (1.97)	0–7		3.51 (2.02)[a]	0– 7
SSBs consumption	.75 (.73)	0–7		.57 (.80)	0– 3.6
Supporting the influence agents in motivating their peers					
Intrinsic motivation	4.61 (1.33)	1–6		4.43 (1.48)	1– 6
Perceived social support	1.91 (.92)	1–6		2.16 (1.13)[a]	1– 6
Descriptive norms	3.64 (.94)	1–6		3.66 (1.18)	1– 6
Injunctive norms	3.73 (1.63)	1–6		3.33 (1.80)	1– 6
Drinking water themselves	4.10 (1.18)	1–6	95% (20)		
Talking about water at school or home	3.05 (.97)	1–6	76% (16)		
Talking about water in the social media platform	2.05 (1.32)	1–6	27% (6)		
Forwarding short videos about water in the social media platform	1.95 (1.02)	1–6	24% (5)		

Note. Percentage (%) refers to the number of influence agents with a response score of ≥3; [a]Findings from *t*-tests indicated significant differences over time; T1 = baseline; T2 = immediately after the start of the intervention.

Interestingly, these open-ended responses also revealed that some (13%) influence agents indicated that the most enjoyable aspect of the training was that they had to secretly encourage their peers to drink more water and thus were together part of a "secret mission":

> *"The fact that it [motivating their peers] had to stay a secret and I am part of a kind of spy-group."*
>
> Boy, 12 years old

Supporting Influence Agents in Motivating Their Peers

Regarding the training process of supporting influence agents in motivating their peers to drink more water, their peers' intrinsic motivation remained stable. More specifically, after exposure to the intervention, the mean score of their intrinsic motivation to drink water was not significantly higher compared to before the intervention, $t(91) = 1.38$ $p = .171$ (see Table 5.2). Similarly, there were no changes in the mean for descriptive norms following the intervention, $t(86) = .17$, $p = .867$ (see Table 5.2), indicating that they did not perceive that their peers drank more water. The peers reported a marginal significant increase in their injunctive norm following the intervention, $t(93) = 1.95$, $p = .054$ (see Table 5.2), which implies that there is a trend showing that they perceived that their peers thought they should drink more water. The targeted peers also reported significantly higher social support to drink water after being exposed to the intervention compared to before the intervention, $t(87) = -2.34$, $p = .021$ (see Table 5.2), meaning that they perceived that their peers more often complimented, reminded, offered, and participated in drinking water with them.

Related to this, the responses of the influence agents revealed that they used various strategies to promote water drinking among their peers. Regarding the water-promoting strategies discussed in the training, influence agents' responses showed that they most often used face-to-face strategies to motivate their peers to drink water. Specifically, 95% (scoring ≥ 3; see Table 5.2) of the influence agents indicated that they had drunk water in front of their peers, and 76% (see Table

5.2) indicated that they had talked to their peers about drinking water at school or home in order to motivate them to drink water. Their open-ended responses about how they promoted water suggested that they often (34%) used the meaningful rationales and benefits that were discussed in the training:

> *"Drink water. It is a good thirst quencher."*
>
> Boy, 11 years old

> *"Water makes you perform better and can make you smart, so no more sugar-sweetened beverages but only water."*
>
> Boy, 11 years old

> *"Saying water is healthy, you should actually drink it [water] more."*
>
> Girl, 10 years old

Twenty-seven percent (see Table 5.2) of the influence agents indicated that they had used the social media platform on the research application to talk to their peers about water drinking, and 24% (see Table 5.2) had forwarded the short videos about drinking water to their peers. The open-ended responses suggested that the influence agents not only motivated their peers by using the strategies discussed in the training, but based on the autonomy-supportive climate during the training, they themselves also devised ways to promote water. For example, some influence agents promoted water drinking by supporting their peers in drinking more water (19%), starting a challenge (3%), simply telling them that they had to drink water (3%), or promising rewards when they drank water (3%):

> *"I asked in class if I had to fill their water bottles and mentioned the benefits of drinking water."*
>
> Boy, 11 years old

"Can I fill your cup with water?"

Girl, 11 years old

"We made it into a challenge, and then we noticed that many children started bringing water to school to put on their table in class."

Girl, 10 years old

"Said to them [their peers], you have to take a bottle to school on Wednesday."

Boy, 11 years old

"I promised awesome rewards when they [their peers] would drink more water."

Girl, 10 years old

The open-ended responses of the influence agents suggested that the training had succeeded in providing some of them with the skills to promote water drinking among their peers. These influence agents namely indicated that they experienced that motivating their peers had gone well and that their peers reacted positively:

"Went well, [name] immediately drank from my bottle of water."

Girl, 11 years old

"They said yes, I am going to do it [drink water]."

Boy, 11 years old

"They said things like 'Yes, you are absolutely right. Thanks for the tip!'"

Girl, 10 years old

However, some influence agents also experienced that motivating their peers to drink water had gone less well. For example, they indicated that they mainly promoted water drinking in their family circle instead of among their peers. Others thought they had not sufficiently motivated their peers and also indicated that the next time they should be more concerned with motivating their peers. In addition, some also found it difficult to encourage their peers to drink more water:

"I mainly tried it [motivating others to drink water] at home."

Girl, 12 years old

"It [motivating others to drink water] went well, but I have not done it often."

Girl, 11 years old

"Motivate my peers more often."

Girl, 12 years old

Additional Exploratory Analyses

To scrutinize the effect of the training on the changes in the peers' intrinsic motivation, social support, and perceived social norms, we also explored for which peers the *Share* H_2O training specifically had caused a greater change.

Pearson's correlation analyses (see Table 5.3) revealed a significant negative relation between sex and changes in social support ($r = -.26$, $p = .013$), indicating that boys had a greater change in social support than girls. There was a significant positive relation between grade level and changes in intrinsic motivation ($r = .22$,

Table 5.3 Correlations between the change variables and peers' demographics

	Sex	Grade level	Family affluence
Changes in peers' intrinsic motivation	.07	.22*	-.17
Changes in peers' social support	-.26*	.19†	.17
Changes in peers' injunctive norms	-.08	.26*	.17
Changes in peers' descriptive norms	-.07	.08	-.12

Note. † $p < .10$, * $p < .05$, ** $p < .01$.

$p = .034$) and injunctive norm ($r = .19$, $p = .078$), and a marginal significant positive relation between grade level and changes in social support ($r = .26$, $p = .011$). This indicates that children in higher grades had a greater change in intrinsic motivation, injunctive norm, and social support. There was no significant relation for family affluence.

DISCUSSION

This study is the first to investigate the process of motivating influence agents to diffuse the target behavior among their peers when implementing a social network intervention, in particular, whether and how applying self-determination theory-based techniques can motivate influence agents and, indirectly, their peers. Diving deeper into this motivational approach and its application in social network interventions provides insights that are valuable for both future research and interventions. The findings of this study are discussed below following the three research aims.

General Experiences with the Training

In general, the findings showed that the influence agents had enjoyed the *Share H_2O* training, found the duration adequate, and experienced it as autonomy supportive. The latter is highly important because an approach is only truly autonomy supportive if the intended individuals actually experience it this manner and not when the trainers alone think they were autonomy supportive. Previous work has shown that, for example, parents tend to overestimate how autonomy supportive they are towards their children (Cheung, Pomerantz, Wang, & Qu, 2016). Our findings suggest that a social network intervention based on the

self-determination theory approach can foster an autonomy-supportive climate, which may have enhanced the influence agents' intrinsic motivation to perform the target behavior.

This approach also fits in the Dutch educational system—and probably in most Western countries—as schools are quite autonomous and have educational freedom (Scheerens, Luyten, & Van Ravens, 2011). Furthermore, an autonomy-supportive learning style is stimulated in the schools where children are granted responsibility and freedom in their learning process (Veugelers, 2004, 2007). This approach could also be integrated into existing dietary intake programs at schools, such as the national approach called Gezonde School [Healthy School] that supports schools in promoting a healthy lifestyle for their students (GGD, 2020). Based on our findings, schools could use an autonomy-supportive approach to motivate healthy dietary behaviors among their students.

Motivating the Influence Agents to Drink Water Themselves

Implementing the self-determination theory-based techniques in the training appeared to have increased the influence agents' intrinsic motivation to drink water and their actual water consumption. Providing meaningful rationales (Gillison et al., 2019; Ryan & Deci, 2000; Teixeira et al., 2020). Especially appears to have motivated the influence agents, as they indicated that they enjoyed this part of the training the most and used the provided rationales to promote water drinking among their peers. Apparently, the provided short-term rationales (Chandran & Menon, 2004) were meaningful for the influence agents. In addition, a self-persuasion technique (Aronson, 1999) was also implemented in the training to encourage the influence agents to drink more water. Even though there was no evidence from the open-ended responses for the effectiveness of this technique, it does not necessarily mean it did not have an effect on motivating the influence agents, as most of them did increase their water consumption following the training.

Supporting the Influence Agents in Motivating Their Peers

Providing the influence agents with the skills to promote the target behavior, by discussing possible water-promoting techniques with them, appears to have actually supported them in motivating their peers, as they mainly used the discussed water-promoting strategies. Of these, the influence agents mainly used face-to-face strategies and less often online strategies. In addition to applying the discussed water-promoting strategies, the influence agents also felt free to choose and devise their own strategies. This resulted in them also using more supportive strategies, such as providing support for the target behavior ("Can I fill your cup with water?"). They may have used these kinds of face-to-face strategies more often because they fit more naturally into their usual peer-to-peer exchanges than online strategies (Sebire et al., 2019).

In addition, our findings showed that the peers did not perceive that the influence agents had changed the descriptive norm concerning water drinking. However, there was a trend indicating that they did perceive that their peers thought that they should drink more water. This could be related to the finding that they also experienced more social support from their peers to drink water. A possible explanation for not finding any changes in the descriptive norm and for the trend for the injunctive norm may lie in the fact that the promotion of these norms must be made salient to achieve an effect (Bicchieri, 2000). However, the underlying approach of social network interventions is that influence agents informally diffuse messages among their peers (Rogers, 2010). Therefore, in the training, the influence agents were taught to promote water using informal and non-salient strategies, such as drinking water themselves. This was done so that their peers would not notice that the agents were trying to influence their behavior and thus avoid reactance to the target health message (Brehm, 1966).

Intervention Refinements

This study identified a number of possible refinements that could be made to *Share* H_2O intervention. First, the influence agents did not succeed in increasing

their peers' intrinsic motivation and some of them even used strategies that could be considered as the opposite of autonomy-support—controlling strategies (Bartholomew, Ntoumanis, & Thøgersen-Ntoumani, 2009)—for instance, by turning it into a challenge and promising rewards. However, previous research has shown that intrinsic motivation, in particular, is a strong predictor of long-term changes in water consumption (Smit et al., 2018). Therefore, the training activities could be improved by having a greater focus on teaching the influence agents to promote water drinking in a manner that fosters an intrinsically motivating environment for their peers. In relation to this, some influence agents also indicated that they had not sufficiently motivated their peers and had difficulty in doing so. Hence, another refinement in the content of influence agent training would be to provide more specific examples of how to promote water consumption but most importantly also practice real-life situations through role play (Audrey, Cordall, Moore, Cohen, & Campbell, 2004). To apply these refinements to the training and thus possibly make the intervention more effective, the contact moments could be extended. This could also contribute to the relatedness with the researchers and among the influence agents themselves (Teixeira et al., 2020).

Unexpectedly, some influence agents indicated that having a secret mission together was the most enjoyable aspect of the training. No part of the training was specifically developed with this intention but having a secret with others—thus group collaboration—may have motivated the influence agents to promote the behavior. By facilitating group collaboration, individuals experience feelings of belonging (i.e., the need for relatedness; Gillison et al., 2019), which may ultimately strengthen their intrinsic motivation (Ryan & Deci, 2000). Therefore, an avenue for refinement could be to emphasize group collaboration among influence agents, by focusing on the secret mission aspect, in order to motivate them to promote the target behavior. In addition, the additional analysis showed that the training approach effected the greatest change for boys and children in higher grade levels. It is therefore essential to make modifications to the training content so that it fits the entire target group. Nevertheless, it is important to note that there appeared to be no differences in changes for children from different levels of family affluence.

Limitations and Suggestions for Future Research

Some limitations should be addressed in interpreting the findings of this study. First, although the current paper collected data from the target group in the intervention (i.e., influence agents and their peers), it is important for future research to conduct a thorough process evaluation of the program, including data from other perspectives involved in the intervention, for example, from the trainers, teachers, and parents. Process evaluations consider factors beyond effectiveness to assess the implementation of the intervention, such as the intervention and theoretical fidelity, dose, reach, and context of the intervention. Examining these factors could help in understanding why a program was successful or not (Grembowski, 2015; Moore et al., 2014; Steckler, Linnan, & Israel, 2002). Related to this, in addition to the quantitative data, the current study only analyzed responses to open-ended questions to evaluate the implementation of the training. Therefore, we consider it important for future research to conduct interviews and focus groups with all parties involved in the social network intervention.

Third, the current study did not explicitly measure the extent to which the self-determination theory-based techniques used in the training facilitated the psychological needs (i.e., autonomy, competence, and relatedness; Deci & Ryan, 2000). It is therefore essential for future research to delve deeper into the process of these psychological mediators by including them as evaluation measures to explore the fidelity of the intervention to self-determination theory (for an example, see Sebire, Kesten, et al., 2016). Finally, the assessment of children's beverage consumption was based on self-report. Although self-reported intakes with multiple 24-h recall measurements, including weekdays and weekend days, are generally considered reliable for children aged 4 to 11 years (Burrows, Martin, & Collins, 2010), one should keep in mind that there is the potential for under- or overreporting (Collins et al., 2010). In addition, parents were not included as reporters to supplement the dietary intake information obtained from the children (Burrows et al., 2010). However, research has shown that children aged 10 years and older can reliably report their intake behavior (Moore et al., 2014).

Nevertheless, an interesting opportunity for future research would be to use an additional methodology, such as observations at school (van de Gaar et al., 2014), and measure the beverage intake from different sources (Loughridge & Barratt, 2005; Muckelbauer et al., 2009).

Conclusion

The findings of this study add important insights to the existing social network intervention literature by shedding light on how we can optimally motivate influence agents to engage in the target behavior and effectively support them in motivating their peers. The current study provides promising evidence for the use of an autonomy-supportive approach in the training of influence agents in social network interventions. In particular, providing personally meaningful rationales for the target behavior, based on short-term benefits, seems to play an important role in motivating primary school children (i.e., aged 9 to 13 years old). Furthermore, for this age group, it seems important that social network interventions focus on providing influencing agents with the skills to use face-to-face strategies, as well as giving them the freedom to choose how they wish to motivate their peers.

6

GENERAL DISCUSSION

The general objective of this dissertation was to investigate the effects of the *Share H_2O* social network intervention to motivate healthy drinking behaviors in influence agents and their peers. This general objective was approached with four specific research aims. The current chapter first provides a brief summary of the main findings followed by a discussion and reflection. Subsequently, general limitations are discussed, along with recommendations for future research and intervention practices. This chapter concludes with the five most important take away messages for researchers as well as practitioners.

SUMMARY OF THE MAIN FINDINGS

Aim 1 (Chapter 2)—Investigate whether a social network intervention grounded in self-determination theory improves children's consumption behaviors

- The *Share H_2O* social network intervention was effective in increasing children's water consumption and decreasing their consumption of sugar-sweetened beverages (SSBs) compared to children who did not receive the intervention.
- The intervention had an effect only on children's reported intake and not on their intentions to drink more water in the near future.

Aim 2 (Chapter 3)—Gain more insight into the role of intrinsic motivation in predicting healthy drinking behaviors compared to other dominant theoretical predictors

- Intrinsic motivation was the most important predictor of long-term changes in water consumption of children.
- Intention to drink more water did not predict long-term changes in children's actual water consumption.
- Of the various types of social norms investigated, only parental descriptive norms predicted long-term changes in water consumption.

Aim 3 (Chapter 4)—Compare the effectiveness of the improved *Share H_2O* social network intervention to a mass media intervention and no intervention

- Children exposed to the improved *Share H_2O* social network intervention consumed less SSBs than those who received no intervention. There was a trend for children exposed to the social network intervention to consume less SSBs compared to those who received the mass media intervention.

- The effectiveness of the improved *Share H_2O* social network intervention on children's water consumption depended on social norms. Specifically, children with initially higher perceived descriptive norms and lower perceived injunctive norms increased their water consumption after the intervention.

Aim 4 (Chapter 5)—Acquire an in-depth understanding of the underlying processes of motivating influence agents, and via them, their peers, to adopt healthy drinking behaviors

- The design of the *Share H_2O* social network intervention fostered an autonomy-supportive climate, enhancing the influence agents' intrinsic motivation to drink water. Providing meaningful rationales based on short-term outcomes to drink water seemed to have particularly motivated them.

- Influence agents mainly used face-to-face strategies, such as modeling, talking with peers, and providing social support, instead of online strategies to promote water consumption among their peers.

- After the *Share H_2O* intervention, the targeted peers experienced more social support and felt that their classmates thought they should drink more water. In addition, their intrinsic motivation to drink water did not increase.

REFLECTIONS ON THE MAIN FINDINGS

In the following sections, we discuss and reflect on the above findings based on the two main perspectives in the theoretical framework of this dissertation. First,

we discuss the main findings from the perspective of self-determination theory, with an emphasis on intrinsic motivation. After that, we discuss the main findings from the perspective of social norms.

The Role of Intrinsic Motivation

This dissertation showed that intrinsic motivation plays an important role in achieving and maintaining healthy drinking behaviors in children. Chapters 2 and 4 of this dissertation showed that the *Share* H_2O intervention, which stimulates positive peer influence and enhances intrinsic motivation, was an effective approach in improving healthy drinking behavior of children. In addition, Chapter 3 showed intrinsic motivation to be an important predictor of maintaining changes in children's water consumption over time. The following sections address the findings regarding intrinsic motivation by discussing them separately for the influence agents and targeted peers.

Intrinsic Motivation of the Influence Agents

Chapter 5 showed that creating an autonomy-supportive climate in the training (Vansteenkiste, Simons, Lens, Soenens, & Matos, 2005), which involved implementing techniques that support the influence agents' psychological basic needs (Ryan & Deci, 2000), enhanced the intrinsic motivation to drink water and increased the actual water consumption of the influence agents. In particular, providing meaningful rationales (Gillison et al., 2019; Teixeira et al., 2020) based on short-term outcomes (Chandran & Menon, 2004) by collaborating together on a word web and an interactive presentation, played an important role in intrinsically motivating them. For instance, the influence agents mentioned that drinking water could help them focus better at school and reduce plastic waste in the ocean. Moreover, supporting the influence agents to generate their own arguments to convince themselves to drink more water also motivated them (Gillison et al., 2019; Teixeira et al., 2020), which was based on the self-persuasion technique (Aronson, 1999). Altogether, an increase in the influence agents' intrinsic motivation may cause the observed changes in their water consumption to persist in the long

term. After all, the findings of Chapter 3 showed that intrinsic motivation is an important predictor for long-term changes in water consumption.

Intrinsic Motivation of the Targeted Peers

Chapter 5 explains the finding that intrinsic motivation was not transferred by the influence agents to their peers. One explanation might be that some influence agents used less autonomy-supportive strategies to promote drinking water, such as strategies that focused on external motivation (Deci & Ryan, 2000; Vansteenkiste et al., 2005). For example, influence agents introduced a challenge or promised rewards. These strategies are more responsive to children's externally regulated motivation. External regulation is the least autonomous form of motivation in which individuals perform the behavior for external rewards or to avoid punishment (Deci & Ryan, 2000). Thus, it could be that the changes in the targeted peers' healthy drinking behaviors were more extrinsically driven and therefore did not increase their intrinsic motivation.

It could also be that children do not become intrinsically motivated after being exposed to influence agents that promote water consumption. It may be that for some children it was too big a step to internalize drinking water and thus enjoy drinking it. Self-determination theory suggests that the individual's motivation for a particular behavior can be placed on a continuum, ranging from amotivation (i.e., a state that reflects a lack of any motivational force to act) to the most autonomous form of motivation (i.e., intrinsic motivation; Ryan & Deci, 2000). Adjacent to intrinsic motivation on the motivation continuum is integrated regulation, which occurs when the behavior is identified as being valued (Deci & Ryan, 2000). Thus, it could be that if children do not like water, they achieve, at the most, an integrated motivation to drink water. To gain more insight into how children's motivation to drink water evolves, future research could include the entire motivation continuum of the self-determination theory (Deci & Ryan, 2000; Pelletier, Tuson, & Haddad, 1997).

Another interesting avenue for further research is to disentangle the effect of the training itself, which focuses on enhancing intrinsic motivation (Ryan & Deci, 2000), from the effect of deploying influence agents. The question is whether the effect of influence agents is crucial or whether the content of the autonomy-supportive training itself is already motivating children to drink more water. It could be that targeting the entire class with the training and allowing children to encourage and support each other to drink water could be fruitful, perhaps even more fruitful than only deploying influence agents. Chapter 4 was designed to compare the effect of the *Share H_2O* social network intervention with a mass media approach (Redman, Spencer, & Sanson-Fisher, 1990) in which the entire class was exposed to a presentation on the benefits of drinking water. However, these findings were not prominent enough to draw a clear conclusion about which approach was most successful. The mass media intervention was not communicated in an autonomy-supportive manner (Vansteenkiste et al., 2005) and children did not have the opportunity to generate their own reasons for drinking water. The question therefore remains whether all children could have been motivated if the entire class had followed the *Share H_2O* training. An approach to investigate this would be to compare the impact of training the entire class simultaneously with training the influence agents only (as done in this dissertation).

The Role of Perceived Social Norms

Most of the chapters (Chapters 3-5) in this dissertation show the important role of perceived social norms in the *Share H_2O* social network intervention. In the following sections, we first reflect on the moderating role of prevailing social norms on the effectiveness of the intervention and then on how the intervention changed the perceived social norms of the children.

Moderating Role of Perceived Social Norms

Chapter 4 showed that the effectiveness of the *Share H_2O* intervention depended on already prevailing social norms among children. First, the intervention was more effective in children who perceived that their classmates were drinking the desirable amount of water before the intervention (i.e., higher descriptive

norms). It may be that these children were more likely to adjust their behavior to the intervention message (i.e., drink more water) because it was congruent with the norm that they perceived beforehand. This reasoning is consistent with the contextual congruence model, which suggests that higher levels of agreement between values, beliefs, and behaviors in the social environments facilitate the internalization process (Spera & Matto, 2007). Second, the intervention was also more effective in children who did not initially perceive that their classmates thought they should drink water (i.e., lower injunctive norms). Research showed that higher levels of injunctive norms can be perceived as coercive pressure from others to perform the behavior (Cialdini et al., 1991), which can evoke resistance to the desired behavior. It may be that children who initially felt pressure from their classmates were less likely to adapt their behavior when exposed to the intervention message and drinking norms conveyed by the influence agents. Chapter 5 showed that the intervention indeed increased the children's perceived injunctive norms.

Interestingly, a similar study conducted in Aruba found an opposite moderating effect for perceived injunctive norms (Franken et al., 2018). In this study the social network intervention was more effective for children who initially thought their peers thought they should drink water (i.e., higher injunctive norms). A possible explanation lies in cross-cultural differences. Although the Dutch culture has many similarities to that of Aruba, Arubans appear to have more collectivistic values, by feeling interdependent and connected with their social environment, than the Dutch, who are more individualistic and refer to themselves as autonomous and separate entities in their social environments (Meijering & Lager, 2014; Merz, Ozeke-Kocabas, Oort, & Schuengel, 2009). Unlike in the Netherlands, the children in Aruba who initially perceived peer pressure were more inclined to adapt their behavior because they felt the need to be part of the social group. This reasoning is consistent with research showing that individuals are susceptible to the influence of individuals with whom they experience shared group membership (Cruwys et al., 2012). Thus, it appears that in more connected social communities, the *Share H_2O* intervention is effective among children who perceive higher levels of

injunctive norms, while in more independent social communities it is effective for lower levels of injunctive norms. This reasoning remains speculative and further research is needed to unravel the role of social norms on the effectiveness of social network interventions in different communities.

It is important to recognize that in the pilot study (Chapter 3), the *Share H_2O* intervention was effective in increasing water consumption among all children, regardless of social norms. The important role of social norms on the effectiveness of the intervention only emerged in the studies that followed (i.e., Chapter 5 and Franken et al., 2018). One reason for this may be that the general opinion about the importance of drinking water has changed over the years. Over the past five years, the health and environmental benefits of drinking water has drawn much (inter)national attention. For example, national organizations have organized various activities in schools, such as letting children "pimp" their own water bottles (JOGG, 2020) and installing water taps in schoolyards (Gezonde school, 2020). These school activities, combined with mass media attention, may have raised awareness of drinking water among children. It may therefore be that for this group, the content of the *Share H_2O* intervention—which mainly focused on the benefits of drinking water—was less new. It would have been interesting if this school and mass media attention for drinking water in combination with the social network intervention had been included as the fourth condition in the RCT in Chapter 5.

Changing Perceived Social Norms

This dissertation also provided preliminary evidence that social network interventions can change water drinking norms. Chapter 5 showed that the targeted peers reported higher levels of injunctive norms after the *Share H_2O* intervention. However, their perceived descriptive norms remained unchanged. A possible reason for this may be related to how the targeted peers perceived the water-promoting strategies applied by the influence agents. In addition to modeling, the influence agents used water-promoting strategies that might have been perceived as pressure by some peers. Strategies such as telling peers they

should drink more water, supporting them by filling their bottle with water, and offering rewards may have caused peers to feel that their classmates expected them to drink more water (i.e., injunctive norm; Cialdini et al., 1991). This may have prompted some of the targeted peers to drink more water and less SSBs in order to make a good impression on others (Vartanian, 2015).

Contrary to our findings, other social network interventions have actually found an increase in descriptive norms (Latkin et al., 2013; Mellanby, Newcombe, Rees, & Tripp, 2001; van Woudenberg et al., 2020). A reason for these contradicting findings could be that in these interventions the influence agents mainly focused on modeling and providing information about the desired behavior. These influence mechanisms probably responded to the perceived descriptive norm of the children. Thus, it seems that the way influence agents promote the behavior, as well as how it is interpreted by their peers (Lapinski & Rimal, 2005), has consequences for the effectiveness of social network interventions. It would be relevant for future research to gain more insight into the relationships between perceived social norms and behavior in social network interventions as well as the functioning of the underlying influencing mechanisms (i.e., social modeling, impression management, or social facilitation).

LIMITATIONS

Self-Reported Data

In all studies in this dissertation, beverage consumption was measured by self-report; children were asked to report how much water they drank the day before. Although these types of measurements are generally found to be reliable (Vereecken & Maes, 2003), there is a chance that children under- or overreport their own beverage consumption (Collins et al., 2010; Lally et al., 2011). The studies in this dissertation attempted to reduce this potential problem by assessing the intake of children multiple times during each data collection (i.e., every other day). Nevertheless, future studies can improve the methodology by using additional and more direct measures, such as observations in schools (Beets, Tilley, Weaver,

Turner-McGrievy, & Moore, 2014), flow meters attached to the water fountains of the schools (Muckelbauer et al., 2009), or 24-hour urine collection (Armstrong, Johnson, McKenzie, & Muñoz, 2013).

Generalizability

Another limitation of this dissertation is the generalizability of the findings. The *MyMovez* research program aimed to recruit a diverse and representative sample of participants. However, the demographics in Chapters 3 and 5 showed that the majority of the children were of normal weight and came from high-income families, while children from low-income families are more likely to be overweight (CBS, 2016) and drink less water (Vieux et al., 2017). This sampling bias may have had an effect on the findings in this dissertation. It is conceivable that the intervention tried to make relatively healthy children healthier. Future research should aim at obtaining a more diverse sample involving more children from low-income families. One way that future research could increase parental consent among low-income families is to make the project information more comprehensible and accessible to these parents. For example, researchers could create a short informational video about the study.

Furthermore, the content of the *Share* H_2O intervention was developed and tested among primary school children. It is conceivable that the current content of the intervention would have a different effect on secondary school students, as it may not match their knowledge and interests. During the transition from primary to secondary school—an important and impactful event for many—young adolescents are faced with the formation of a new "world" for themselves, with major changes in the individual and social context (Brown & Larson, 2009; Evans, Borriello, & Field, 2018). Therefore, the *Share* H_2O intervention should be adapted to the corresponding age group. The current content was developed and refined through input from primary school children; however, this can be done even more thoroughly in future research through co-creation with the target group. In this approach, children and adolescents are involved throughout the development of the intervention content, taking into account their vision and responding to their

autonomy (Anselma et al., 2019; Visser et al., 2005). This co-creative approach ensures that the designed interventions meets the needs and interests of the targeted children and adolescents (Ozer, Ritterman, & Wanis, 2010).

Focus on Peers

This dissertation focused only on peer influence, although there are other significant influences in the social environment of children such as parents, teachers, and athletic coaches. The literature indicates that, especially among primary school children, parents also play an important role in terms of social norms (Bevelander et al., 2020), but also through access and availability of food at home, modeling and social facilitation (Salvy, Elmo, Nitecki, Kluczynski, & Roemmich, 2011; Yee, Lwin, & Ho, 2017). This was also confirmed in Chapter 3 and, therefore, it is conceivable that these parental influences may interact with the effects of the *Share* H_2O intervention, especially when parents do not drink enough water (Vieux et al., 2020). Future research should aim at obtaining and mapping the entire social environment of children, that is, the social influences both inside and outside the classroom (Kiesner, Kerr, & Stattin, 2004). This insight would provide information about how these different actors influence each other and on which actors interventions should focus. New analysis techniques, such as agent-based modeling (bandini, Manzoni, & Vizzari, 2009), make it possible to analyze complex influence networks. Agent-based modeling can stimulate the communication among the actors in an entire social environment, leading to a better understanding of the impact on behavior (e.g., Giabbanelli, Alimadad, Dabbaghian, & Finegood, 2012; van Woudenberg et al., 2019).

Conceptualization of Intrinsic Motivation

In this dissertation only the intrinsic motivation to drink water was measured in order not to burden the children with too many questions. However, the results in this dissertation indicated that it would be worthwhile to delve deeper into the underlying mediators of intrinsic motivation. According to self-determination theory, the degree of intrinsic motivation depends on whether and to what extent an individual's basic psychological needs (i.e., autonomy, competence and

relatedness) are facilitated (Ryan & Deci, 2000). Future research could measure these self-determination theory-related psychological mediators (namely, autonomy, competence, and relatedness) to gain more insight into how to optimally promote intrinsic motivation (Vlachopoulos & Michailidou, 2006). This could provide guidance for water promotion intervention developers in choosing and applying self-determination theory-related motivational strategies (Gillison et al., 2019; Teixeira et al., 2020).

IMPLICATIONS FOR RESEARCH AND INTERVENTION PRACTICE

The Motivation of Children

Chapter 3 indicated, in line with other literature, that intrinsic motivation plays an important role in predicting long-term changes in health behaviors (e.g., Mata et al., 2009; Pelletier et al., 2004; Ryan et al., 2008; Silva et al., 2011; Teixeira et al., 2015). We therefore recommend social network intervention developers, in addition to the influence agents, to focus on enhancing the intrinsic motivation of the target children. This could be achieved by teaching the influence agents, through role-play for example, to use autonomy-supportive water-promoting techniques that reinforce the intrinsic motivation of their peers (Sebire, Edwards, et al., 2016). However, this would mean that the influence agents training would become longer and more intensive, because in addition to practicing through role-playing, they would also need to learn the core idea behind being autonomy supportive. Another possibility, and probably less time consuming, would be to prompt the influence agents after a certain period of time to actively promote the behavior among their peers again. Research on the application of habit formation for health behavioral change has shown that through repetition a habit (in this case drinking more water) can gradually become a routine (Gardner & Rebar, 2019; Lally & Gardner, 2013). However, future research should investigate whether this possibility could lead to long-term effects for social network interventions.

The Impact of the Intervention

This dissertation demonstrated that the *Share H_2O* intervention can improve children's healthy drinking behaviors. However, it is important to note that these changes in beverage consumption were small—about a quarter of a serving per day. Nevertheless, previous research has shown that even small changes in daily intake can have an impact on children's weight. In fact, consuming just one serving of SSB per day appears to lead to an additional weight gain of 6.75 kg in one year (Apovian, 2004). From this perspective, reducing children's SSB consumption with a quarter of a serving per day over a longer period of time could be a step in the right direction in preventing childhood overweight and obesity. To determine the impact of these small changes in beverage consumption, it would be interesting for future research to perform a cost-effectiveness analysis. In such analyses, the implementation costs of the intervention are compared with the outcomes measured in natural units, in this case per healthcare cost reduction (Gray, Clarke, Wolstenholme, & Wordsworth, 2011; Weinstein & Stason, 1977).

Although the changes in consumption behavior caused by the *Share H_2O* social network intervention appeared to be small, they were found to be greater than other interventions promoting water consumption. A recent meta-analysis conducted among 24 interventions that showed an improvement in children's healthy drinking behavior concluded the following:

> "Two studies, an RCT by Smit et al. that used a peer influence intervention strategy and a large non-RCT by Muckelbauer et al. that installed water fountains at schools had a larger effect compared with the effect of most other studies included in our review" (Franse et al., 2020, p. 9).

The findings of this meta-analysis imply that promoting change in the social and/or physical environment are effective intervention strategies for encouraging water consumption among children. Future research should investigate the effect of a combined approach, implementing both the *Share H_2O* intervention and installing

water fountains in schools (Muckelbauer et al., 2009), as a possible way to improve the impact on children's water consumption. This combined approach is largely consistent with the Capability, Opportunity, Motivation, Behavior (COM-B) model (Michie, Van Stralen, & West, 2011). This model posits behavior as the result of an interaction between having the physical and social opportunities, motivation, and the capability to perform the behavior (Atkins & Michie, 2013). A next step for future research could be to apply the entire COM-B model to improve healthy drinking behaviors in children, thus not only focusing on physical (i.e., installing water fountains) and social opportunities (i.e., peer influences) and motivation (i.e., increasing intrinsic motivation), but also on the capability of children (i.e., increasing knowledge of drinking water; Atkins & Michie, 2013).

The Offline and Online Social Networks of Children

The findings of this dissertation can serve as a basis for translation to other social networks of children. Aside from the classroom networks, the *Share* H_2O intervention approach can also be applied in, for example, children's sports, music, scouting, theater, and other clubs. Researchers could then investigate how the behavior spreads across these different social networks by, for example, tracking the interactions between children via a Bluetooth signal on their smartphone devices (van Woudenberg et al., 2020) and measuring the behavior of the person they have spent time with. It can also be fruitful to target children's *online* social networks. Today's children spend a lot of time using social media platforms (Chassiakos et al., 2016; Valkenburg & Piotrowski, 2017) and are often permanently connected to their online social networks through these platforms (Boyd, 2014). However, we recommend social network intervention developers to not translate the entire *Share* H_2O intervention into an online environment. A recent social network intervention in which influence agents were trained online instead of face-to-face (as in the current dissertation) showed no effect on the behavior of the targeted adolescents (van Woudenberg et al., 2018). The researchers argued that this less personal approach resulted in lower involvement of the influence agents. It is, therefore, advisable to maintain the training of the influence agents face-to-face.

The question remains: which influence agents should be trained face-to-face in children's widespread online social networks, which might differ from offline classroom networks? A relatively new marketing strategy, called influencer marketing (Brown & Hayes, 2008), offers new possibilities for the selection of influence agents in online social networks. In influencer marketing, social media celebrities are sponsored as "influencers" to shape their followers' opinions by subtly or overtly endorsing products on social media (Brown & Hayes, 2008). Social media influencers appear to impact consumer behavior and unhealthy food intake in children (de Veirman, Hudders, & Nelson, 2019). However, it is not yet clear whether these social media influencers can also be deployed to promote healthy food intake in children's online social networks. There are promising results from a recent study showing that popular social media influencers promoting healthy foods can change a late adolescent's healthy food attitude and purchase intention (Folkvord, Roes, & Bevelander, 2020). Thus, an important avenue for future research would be to investigate which type of influence agents are the most successful in children's online social networks. One way to investigate this could be to measure the transmissibility of the behavior between different types of influence agents, such as celebrities and peer influencers (Ni, Chan, Leung, Lau, & Pang, 2014).

TAKE AWAY MESSAGES

In the following section, the most important conclusions of this dissertation are formulated in five main take away messages for research as well as intervention practice.

1. The *Share* H_2O social network intervention is a promising approach to improve healthy drinking behaviors in children by stimulating positive peer influence and enhancing intrinsic motivation.

2. Social network intervention developers should focus on creating an autonomy-supportive context in the training to motivate the influence agents to adopt the behavior and support them in motivating their peers as well.

3. Peer norms play an important role in social network interventions, affecting the impact of social network interventions and by changing them through social network interventions.

4. The approach and design of the *Share H_2O* social network intervention could be used as a blueprint for interventions in other health-related behaviors and other (online) social networks.

5. Intervention developers should focus on an integrated approach to address the healthy drinking behavior of children. In addition to peer influence and intrinsic motivation, they could also focus on other social influences (e.g., parents and teachers), offer a physical environment that enables the behavior, and increase children's knowledge about drinking water.

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DECLARATIONS

This dissertation was part of the *MyMovez* research program funded by the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013) / ERC grant agreement n° [617253]. The study procedures in this dissertation were approved by the Ethics Committee of the Faculty of Social Sciences at Radboud University (ECSW2014-1003-203/ ECSW2014-100614-222). The *MyMovez* research program was also approved by the ethical review board of the European Research Council (617253).

DATA MANAGEMENT

The Radboud University and the Behavioural Science Institute (BSI) have set strict conditions for the management of research data. The research data is this dissertation are treated in accordance with the university's research data management protocol (https://www.ru.nl/rdm/), which is approved by ethical review board of the European Research Council. Research data from the *MyMovez* research program that are suitable for reuse have been made available in DANS (https://doi.org/10.17026/dans-zz9-gn44) for the scientific community, along with the associated metadata and documentation needed to understand the data.

DUTCH SUMMARY (SAMENVATTING)

Het toenemend aantal kinderen met overgewicht en obesitas is één van de grootste gezondheidsproblemen van de laatste drie decennia. Volgens de Wereldgezondheidsorganisatie zijn er wereldwijd meer dan 340 miljoen kinderen met overgewicht of obesitas. In Nederland heeft 14% van de kinderen overgewicht en 2% obesitas. Overgewicht en obesitas op jonge leeftijd heeft vele gezondheidsrisico's, waaronder een verhoogd risico op het ontwikkelen van obesitas op latere leeftijd, het ontwikkelen van hart- en vaatziekten en insulineresistentie op jonge leeftijd en het vroegtijdig komen te overlijden.

Het drinken van suikerhoudende dranken is één van de oorzaken van overgewicht en obesitas bij kinderen. Het nuttigen van minstens één suikerhoudende drank per dag kan leiden tot een extra gewichtstoename van ongeveer 7 kilogram in één jaar. Het is dus belangrijk om de consumptie van suikerhoudende dranken te beperken om overgewicht en obesitas op jonge leeftijd te voorkomen. Een mogelijke oplossing hiervoor is het stimuleren van gezondere alternatieven, zoals het drinken van water. Het vervangen van suikerhoudende dranken door water kan een gunstig effect hebben op het lichaamsgewicht van kinderen. De waterinname van kinderen is echter al vele jaren relatief laag. Het is dus essentieel om de consumptie van water bij kinderen te bevorderen als alternatief voor suikerhoudende dranken.

Sociale Netwerk Interventies

Uit de wetenschappelijke literatuur is bekend dat het observeren van en omgaan met leeftijdsgenoten het eet- en drinkgedrag van kinderen kan beïnvloeden. Een benadering dat gebruik maakt van de invloed die leeftijdsgenoten op elkaar hebben om gezondheidsgedrag te bevorderen is de sociale netwerk interventie. In sociale netwerk interventies wordt een aantal kinderen geselecteerd en getraind als *influence agents* om het gewenste gezondheidsgedrag te verspreiden onder hun leeftijdsgenoten. Eén van de bekendste sociale netwerk interventies die

relevant is voor dit proefschrift, is de ASSIST interventie (A Stop Smoking In School Trial). In de ASSIST interventie noemden kinderen hun leeftijdsgenoten in een aantal vragen, bijvoorbeeld: "Wie zijn goede leiders in de klas?" en "Tegen wie kijk je op in de klas?". De leeftijdsgenoten die het meest werden genoemd, werden geselecteerd als *influence agents*. Zij werden vervolgens getraind hoe ze het gezondheidsgedrag—in dit geval stoppen met roken—konden verspreiden onder hun leeftijdsgenoten. In dit proefschrift werd de hierboven beschreven sociale netwerkbenadering gebruikt als basis om de *Share H_2O* interventie te ontwikkelen. In de *Share H_2O* sociale netwerk interventie werden *influence agents* gemotiveerd tijdens hun training om zelf meer water te drinken en om de consumptie van water—als alternatief voor suikerhoudende dranken—aan te moedigen onder hun leeftijdsgenoten.

Zelfdeterminatietheorie

Om de *influence agents* te motiveren en trainen in hun rol als *influence agent*s gebruikten we inzichten vanuit de zelfdeterminatietheorie, ontwikkeld door Deci en Ryan (2000). Zij veronderstellen dat intrinsieke motivatie, oftewel de mate waarin iemand iets interessant of leuk vindt om te doen, een belangrijke bijdrage speelt bij het veranderen van een gezondheidsgedrag. Om intrinsiek gemotiveerd te zijn, moet aan drie psychologische basisbehoeften worden voldaan: autonomie, competentie en sociale verbondenheid. Dat kan worden bereikt door gebruik te maken van een autonomie-ondersteunende aanpak. Een autonomie-ondersteunende aanpak is een combinatie van het ophalen van betekenisvolle drijfveren, keuzes, en het aanmoedigen van zelfinitiatief op een zorgzame manier. In dit proefschrift streefden we ernaar om een autonomie-ondersteunende context te creëren in de training van de *influence agents* om hen, en via hen hun leeftijdsgenoten intrinsiek te motiveren om water te drinken.

DOEL VAN DIT PROEFSCHRIFT

Het doel van dit proefschrift was om de effecten van de *Share H_2O* sociale netwerk interventie op het motiveren van gezond drinkgedrag bij de *influence agents* en hun leeftijdsgenoten te onderzoeken. Dit doel werd benaderd met vier specifieke

onderzoeksdoelen. Het eerste onderzoeksdoel was om te testen of de *Share H_2O* sociale netwerk interventie gebaseerd op zelfdeterminatietheorie gezond drinkgedrag bij kinderen kon bevorderen. Het tweede onderzoeksdoel was om na te gaan hoe de interventie verbeterd kon worden door meer inzicht te krijgen in de rol van intrinsieke motivatie bij gezond drinkgedrag van kinderen. Het derde onderzoeksdoel was om de effectiviteit van de verbeterde *Share H_2O* sociale netwerk interventie te vergelijken met een massamedia interventie. Als laatste was het vierde onderzoeksdoel om meer inzicht te krijgen in hoe de *influence agents*, en via hen hun leeftijdsgenoten, gemotiveerd werden om gezonder te drinken. Al deze studies maakten onderdeel uit van het *MyMovez* onderzoeksprogramma.

Het *MyMovez* Onderzoeksprogramma

Het *MyMovez* onderzoeksprogramma was een grootschalig onderzoeksprogramma dat tot doel had theorie en methoden te ontwikkelen en te testen voor een effectieve implementatie van gezondheidscampagnes via het sociale netwerk van jongeren. In dit programma ontvingen de participanten het *Wearable Lab*, een smartphone met een vooraf geïnstalleerde onderzoeksapp en een om de pols gedragen bewegingsmeter. Via de onderzoeksapp ontvingen participanten dagelijks vragenlijsten en konden ze gebruik maken van een sociale media platform (*Social Buzz*), een gepersonaliseerde avatar aanmaken en een puzzelspel spelen (Zoko). In de *Social Buzz* konden deelnemers chatten, foto's en korte video's delen met hun leeftijdsgenoten en ook contact opnemen met de onderzoekers. In de *Share H_2O* sociale netwerk interventie werd het *Wearable Lab* gebruikt om het gedrag van kinderen te meten en het sociale media platform kon door de *influence agents* gebruikt worden om het water drinken onder hun leeftijdsgenoten aan te moedigen.

Opbouw van het Proefschrift

Dit proefschrift bestaat uit een introducerend hoofdstuk, vier empirische hoofdstukken die afzonderlijk ingaan op de vier onderzoeksdoelen en een afsluitend hoofdstuk waarin de belangrijkste bevindingen en aanbevelingen voor zowel toekomstig onderzoek als de praktijk worden bediscussieerd.

Hoofdstuk 2—Het effect van de *Share H_2O* sociale netwerk interventie op het gezond drinkgedrag van kinderen

Hoofdstuk 2 beschrijft een studie waarin is onderzocht of de *Share H_2O* sociale netwerk interventie, gebaseerd op zelfdeterminatietheorie, een aanpak zou kunnen zijn om het drinkgedrag van kinderen positief te veranderen. Om dit te testen werden kinderen willekeurig toegewezen aan ofwel de *Share H_2O* interventie of geen interventie. In de *Share H_2O* interventie werd een aantal kinderen geselecteerd en getraind als *influence agents* om het drinken van water—als alternatief voor suikerhoudende dranken—te promoten onder hun leeftijdsgenoten. De *Share H_2O* interventie volgde grotendeels de ASSIST benadering voor het selecteren van de *influence agents*. Om de *influence agents* te motiveren om het drinken van water te promoten onder hun leeftijdsgenoten, volgden zij een autonomie-ondersteunende training. De training bestond uit twee delen. Het eerste deel was erop gericht om de *influence agents* aan te moedigen zelf meer water te drinken. Het tweede deel was erop gericht om de *influence agents* te ondersteunen in hun rol om hun leeftijdsgenoten te motiveren meer water te drinken.

De resultaten van deze studie lieten zien dat een sociale netwerk interventie, gebaseerd op inzichten uit de zelfdeterminatietheorie, gezond drinkgedrag kan bevorderen. Kinderen die blootgesteld werden aan de *Share H_2O* interventie dronken meer water en minder suikerhoudende dranken dan kinderen die geen interventie kregen. De interventie had alleen een effect op het drinkgedrag van kinderen en niet op hun intentie om in de nabije toekomst meer water te drinken. Een mogelijke verklaring hiervoor zou kunnen zijn dat kinderen, die blootgesteld werden aan de *Share H_2O* interventie, het waterdrinkgedrag van de *influence agents* hadden overgenomen zonder zich hiervan bewust te zijn.

Hoofdstuk 3—Een geïntegreerd model om na te gaan waarom kinderen water drinken

Hoofdstuk 3 beschrijft een studie naar de rol van intrinsieke motivatie bij het ontwikkelen van gezond drinkgedrag bij kinderen. De studie bestond uit een geïntegreerd model dat onderzocht welke factoren uit verschillende theoretische

perspectieven het meest bijdragen aan waarom kinderen water drinken. Ten eerste bevatte het model factoren uit de theorie van gepland gedrag: intentie (is iemand van plan meer water te drinken), waargenomen gedragscontrole (denkt iemand meer water te kunnen drinken), attitude (drinkt iemand graag water), en injunctieve norm (denkt iemand dat anderen vinden dat hij water moet drinken). Ten tweede, vanuit het sociale normen perspectief, omvatte het model de descriptieve norm (denkt iemand dat anderen water drinken). Als laatste, vanuit de zelfdeterminatietheorie, werd ook intrinsieke motivatie (vindt iemand het drinken van water leuk) in het model opgenomen.

De resultaten van deze studie lieten zien dat intrinsieke motivatie de belangrijkste factor was voor kinderen om water te drinken. Kinderen dronken meer water wanneer ze intrinsiek gemotiveerd waren, oftewel wanneer ze het echt wilden en leuk vonden om te doen. Hoewel kinderen een hogere intentie hadden om in de nabije toekomst water te drinken, had dit geen invloed op het daadwerkelijk water drinken. Van de verschillende soorten sociale normen die werden onderzocht, had alleen de descriptieve norm van de ouders een invloed. Kinderen dronken meer water als ze dachten dat hun ouders vaak water dronken.

Hoofdstuk 4—Vergelijking van de *Share H_2O* sociale netwerk interventie met een massamedia interventie

Hoofdstuk 4 beschrijft een studie waarin de effectiviteit van de verbeterde *Share H_2O* sociale netwerk interventie werd vergeleken met een massamedia interventie. Om dit te testen werden kinderen willekeurig toegewezen aan de *Share H_2O* interventie, de massamedia interventie of geen interventie. De aanpak van de *Share H_2O* interventie was vrijwel gelijk aan degene beschreven in hoofdstuk 2. We streefden er echter naar om de inhoud van de training te verbeteren door meer principes van de zelfdeterminatietheorie op te nemen om de *influence agents* te ondersteunen in het promoten van water drinken op een autonomie-ondersteunde manier. Dit had als doel de intrinsieke motivatie van hun leeftijdsgenoten te verhogen. In de massamedia interventie kregen de kinderen kennis over de voordelen van het drinken van water door middel van

een interactieve presentatie. Deze voordelen waren dezelfde als die besproken werden in de training van de *influence agents.*

De resultaten van deze studie lieten zien dat kinderen blootgesteld aan de *Share H_2O* interventie ongeveer een kwart glas minder suikerhoudende dranken dronken dan kinderen die de massamedia interventie of geen interventie kregen. Wat betreft het drinken van water bleek de effectiviteit van de *Share H_2O* interventie afhankelijk te zijn van de sociale normen. Alleen kinderen blootgesteld aan de *Share H_2O* interventie, die aanvankelijk dachten dat hun leeftijdsgenoten vaak water dronken en niet het gevoel hadden dat hun leeftijdsgenoten dachten dat zij water zouden moeten drinken, dronken meer water dan de andere kinderen.

Hoofdstuk 5—Een evaluatie van de *Share H_2O* sociale netwerk interventie

Hoofdstuk 5 beschrijft een studie die evalueerde hoe inzichten uit de zelfdeterminatietheorie werden toegepast in de training van *Share H_2O* interventie met als doel de *influence agents*, en via hen hun leeftijdsgenoten, te motiveren om een gezond drinkgedrag te ontwikkelen. Dit werd gedaan door zowel de *influence agents* als hun leeftijdsgenoten na afloop van de interventie een aantal vragen te stellen. Allereerst gaven de *influence agents* aan hoeveel water zij dronken en of ze intrinsiek gemotiveerd waren om water te drinken. Ze gaven ook aan welke strategieën in de training ervoor hadden gezorgd dat ze gemotiveerd waren om meer water te drinken en welke promotietechnieken zij hadden gebruikt om hun leeftijdsgenoten te motiveren. Om te evalueren hoe hun leeftijdsgenoten deze promotietechnieken zagen, gaven de leeftijdsgenoten aan of ze intrinsiek gemotiveerd waren om water te drinken, of ze zich gesteund voelden in het drinken van water en of ze het gevoel hadden dat anderen vonden dat ze meer water moesten drinken.

De resultaten van deze studie lieten zien dat de training effectief was in het verhogen van de intrinsieke motivatie van de *influence agents* om meer water te drinken en hun daadwerkelijke waterconsumptie. Vooral het bespreken van betekenisvolle

drijfveren voor het drinken van water leek hen te hebben gemotiveerd. Om het drinken van water bij hun leeftijdsgenoten te promoten, gebruikten de *influence agents* vooral face-to-face technieken, zoals het goede voorbeeld geven, met leeftijdsgenoten praten over het drinken van water en hen steunen bij het drinken van water. Ze bleken weinig gebruik te maken van onlinetechnieken, zoals het delen van berichten over water drinken via het sociale media platform (*Social Buzz*). De *influence agents* slaagden erin om hun leeftijdsgenoten zich meer gesteund te laten voelen in het drinken van water en het gevoel te geven dat anderen vinden dat zij meer water moeten drinken. De *influence agents* slaagden er niet in de intrinsieke motivatie van hun leeftijdsgenoten te verhogen.

Hoofdstuk 6—Discussie

Dit proefschrift sluit af met een hoofdstuk waarin de belangrijkste bevindingen bediscussieerd worden. Allereest liet dit proefschrift zien dat intrinsieke motivatie een belangrijke rol speelt bij het bevorderen van gezond drinkgedrag bij kinderen. De *Share* H_2O sociale netwerk interventie, dat zich richt op het verhogen van intrinsieke motivatie, bleek effectief te zijn in het bevorderen van een gezond drinkgedrag bij kinderen. Intrinsieke motivatie bleek ook de belangrijkste voorspeller te zijn voor waarom kinderen water drinken. Ten tweede liet dit proefschrift zien dat sociale normen een grote rol spelen in de *Share* H_2O interventie. De effectiviteit van de interventie bleek af te hangen van de bestaande normen over het drinken van water. De *Share* H_2O interventie was alleen effectief voor kinderen die aanvankelijk dachten dat hun leeftijdsgenoten vaak water dronken en niet het gevoel hadden dat hun leeftijdsgenoten dachten dat zij water zouden moeten drinken. Anderzijds bleek de *Share* H_2O interventie ook de normen over het drinken van water te kunnen veranderen. Kinderen bleken na de interventie het gevoel te hebben dat anderen vonden dat ze meer water moesten drinken.

Vervolgens bediscussieert dit hoofdstuk hoe bepaalde aspecten de resultaten van dit proefschrift hebben kunnen beïnvloeden. Allereerst is het consumptiegedrag van de kinderen gemeten door zelfrapportage. Er is een kans dat kinderen hun eigen consumptie hebben onder- of overschat. Daarom zou toekomstig onderzoek

meer directe meetinstrumenten kunnen gebruiken, zoals observaties in scholen, watermeters aan de waterfontein van scholen of 24-uurs urineverzameling. Ten tweede bleek de meerderheid van de kinderen een normaal gewicht te hebben en uit gezinnen met een hoog inkomen te komen, terwijl juist kinderen uit gezinnen met een laag inkomen meer kans hebben op overgewicht en minder water drinken. Het is goed voorstelbaar dat de *Share H_2O* interventie getracht heeft relatief gezonde kinderen gezonder te maken. Toekomstig onderzoek zou zich moeten richten op het werven van een meer diverse onderzoeksgroep met meer kinderen uit gezinnen met lage inkomens. Tot slot heeft dit proefschrift zich alleen op de invloed van leeftijdgenoten gericht, hoewel er ook andere belangrijke invloeden zijn in de sociale omgeving van kinderen, zoals ouders, leraren en sportcoaches. Het is bijvoorbeeld mogelijk dat de invloed van ouders interfereert met de effecten van de *Share H_2O* interventie, vooral wanneer ouders niet genoeg water drinken. Toekomstig onderzoek zouden kunnen proberen om de gehele sociale omgeving van kinderen te betrekken in de interventie.

Het hoofdstuk sluit af met de sterke punten van dit proefschrift. Eén van de belangrijkste implicaties van dit proefschrift is dat de *Share H_2O* sociale netwerk interventie een veelbelovende aanpak is om gezond drinkgedrag bij kinderen te verbeteren door positieve invloed van leeftijdsgenoten te stimuleren en de intrinsieke motivatie te versterken. Daarnaast laat dit proefschrift zien dat ontwikkelaars van sociale netwerk interventies zich moeten richten op het creëren van een autonomie-ondersteunende context in de training om de *influence agents* te motiveren om het gezondheidsgedrag over te nemen en hen te ondersteunen in het motiveren van hun leeftijdsgenoten. Tot slot kan de aanpak en het ontwerp van de *Share H_2O* sociale netwerk interventie gebruikt worden als blauwdruk voor interventies in andere gezondheidsgedragingen en in andere sociale netwerken van kinderen, maar ook in hun online sociale netwerken.

ACKNOWLEDGEMENTS (DANKWOORD)

Het is zover, mijn proefschrift, mijn eerste baby is eindelijk af! Het schrijven van dit proefschrift was een lang proces en heeft een aantal jaren in beslag genomen waarin ik veel mooie ups maar ook een aantal grote downs heb meegemaakt. Gedurende deze jaren hebben een aantal mensen direct en indirect bijgedragen en mij gesteund gedurend dit proces, die ik graag hiervoor zou willen bedanken.

Allereerst wil ik mijn begeleidingsteam bedanken, zonder jullie had ik deze mijlpaal nooit bereikt. Jullie hebben me optimaal begeleid tijdens het hele PhD proces, en waren er zelfs om me op te vangen en te steunen als één grote familie toen ik dat keihard nodig had. Mijn dank hiervoor is enorm groot!

Moniek, mijn promotor en principal investigator of het *MyMovez* onderzoeksprogramma. Door jouw kennis en expertise, en door altijd bereid te zijn dit met mij te delen, heb ik de afgelopen jaren veel geleerd. Hierdoor heb ik veel meer zelfvertrouwen gekregen en ben ik opgebloeid tot een echte tijger! Bedankt dat je me altijd hebt aangemoedigd om kansen te grijpen en mij dit ook als onderzoeker te gunnen. Ik heb het als ontzettend fijn ervaren dat je me de ruimte gaf om mijn eigen baby binnen het *MyMovez* onderzoeksprogramma verder te ontwikkelen, ook toen ik soms nogal eigenwijs was in het willen schrijven van bepaalde papers. Naast onze passie om met onderzoek een positieve bijdrage te leveren aan de samenleving, delen we ook een liefde voor de eilanden. Ik vond het ook echt fantastisch dat ik de kans kreeg om je rond te leiden op Aruba en je te laten zien waar ik ben opgegroeid. Nu alleen nog onze droom realiseren om in Rotterdam, and not to forget in samenwerking met de eilanden, een succesvolle living lab op te zetten. Let's go for it!

Rebecca, mijn dagelijkse supervisor en mede SDT-believer. Het was dankzij jou dat ik in de onderzoekswereld terecht ben gekomen en nu een "Crystal Clear" proefschrift heb. Ik zal nooit het moment vergeten dat ik je belde om het idee te bespreken om geen stage te doen voor mijn master pedagogische wetenschappen,

maar, aangestoken door jouw intrinsieke motivatie voor wetenschap, te solliciteren voor de research master. Je enthousiasme was de juiste push dat ik op dat moment nodig had! Je geloofde meteen in mij als onderzoeker en hebt me echt geholpen om de juiste beslissingen te nemen in mijn loopbaan en, het allerbelangrijkste, om altijd mijn hart te volgen. Naast dat je een grote steun was op het gebied van werk, heb ik onze vele gesprekken over andere dingen, zoals onze kids, zeer gewaardeerd. Je hebt me op die manier geleerd dat het goed is om ambitieus te zijn in je werk, maar dat het niet het allerbelangrijkste is in het leven. Bedankt hiervoor!

Kris, ook mijn dagelijkse supervisor (ik had het geluk dat ik er twee had!) en de wetenschappelijke coördinator van het *MyMovez* onderzoeksprogramma. Ik heb de afgelopen jaren veel van jou geleerd over sociale normen en eetgedrag, waardoor ik nu zelf al deze inzichten heb kunnen gebruiken in mijn proefschrift. Zonder deze kennis en jouw input was het nooit zo'n mooi stuk geworden. Ik heb onze samenwerking altijd heel prettig ervaren, maar vooral ook jouw hulp bij het kraken van de "social norms nootje". Daarnaast heeft je oprechte interesse in de moeilijke momenten in mijn leven, mij veel goed gedaan. Je telefoontjes waren altijd op de juiste momenten en daar ben ik je zeer dankbaar voor.

Bill, the statistical genius of the *MyMovez* research program, and my statistics hero. Over the past years you have taught me a lot about statistics and were always willing to help me out. You tried several times to get me to switch to R, you almost succeed, but I always had another excuse, data collection, another paper, lockdown…. I promise this is still my goal for the coming year! I think that I was very fortunate to have you on the supervision team, especially for being "Zwitserland" in my supervision meetings. I am very grateful that you tried to create order in our sometimes chaotic team meetings and kept me calm when I was going crazy with the errors in MPlus. Thanks Bill!

Zo'n groot project als *MyMovez* bestond natuurlijk ook uit meerdere mensen. Allereerst wil ik Thabo en Laura bedanken. T, mede PhD-er binnen het project, the physical activity guy of the project, en nu weer mijn collega bij de EUR. Onze

samenwerking begon al tijdens onze research master toen we beiden de keuze maakten om ons major project bij CW te doen. Daarna kwam je, helaas voor jou, niet meer van me af! Het discussiëren over het selecteren en trainen van *influence agents* en mijn analyses heeft me altijd kritisch naar mijn werk doen kijken. Het was fijn om een PhD-er te hebben bij de tegenslagen van het project, maar ook bij de mooie momenten. Laura, de projectcoördinator van het *MyMovez* onderzoeksprogramma en mijn kamergenoot. Onze samenwerking begon al voor *MyMovez* en ik was erg blij dat je bij het team aansloot. Je hebt veel betekend voor het *MyMovez* onderzoeksprogramma, vooral in het regelen van respondenten en het scheppen van orde in alle documenten, handleidingen, databestanden, etc. Maar daarnaast hebben we ook buiten het werk een mooie band opgebouwd, met als kers op de taart tegelijk zwanger zijn en met onze gezinnetjes naar Aruba gaan. L, zonder jou zou ik al lang gestopt zijn met mijn PhD. Bedankt dat je er altijd voor me was!

Daarnaast wil ik alle student-assistenten bedanken voor hun inzet tijdens het *MyMovez* onderzoeksprogramma. In het bijzonder Aimee de Klein, Milou Bootsma, Elsemieke Laset, Marieke Boschma, en Anne Vlaanderen voor het geven van de training aan de *influence agents*. En ook Rick van den Bosch en Joeri Troost voor het gereedmaken van alle materialen voor het *Wearable Lab* zodat we altijd klaar waren om naar de scholen te gaan. Bram en de collega's van SST, bedankt voor het ontwerpen van de *MyMovez* app en het direct bijspringen als we een foutmelding kregen. Maar zonder respondenten was het *MyMovez* onderzoeksprogramma natuurlijk nooit gelukt. Daarom wil ik alle kinderen enorm bedanken voor hun inzet voor dit project. In het bijzonder, de *influence agents* zonder jullie was het project nooit zo'n succes geworden. Daarbij wil ik ook alle contactpersonen die hebben meegewerkt aan het onderzoek bedanken voor hun tijd en inzet.

Graag wil ik ook de leden van de dissertatie commissie bedanken voor de tijd die zij in het beoordelen van mijn proefschrift hebben gestoken.

Uiteraard wil ik ook alle collega's van CW bedanken. Ik ben erg dankbaar dat ik mijn PhD project bij jullie heb mogen uitvoeren. Jullie vormen met z'n allen een zeer

inspirerende en ambitieuze afdeling en ben trots dat ik bij zo'n afdeling heb mogen werken. Ik kijk terug op fantastische jaren bij CW, met inspirerende meetings, en gezellige gesprekken en uitjes. Heb me altijd zeer welkom gevoeld! Tot slot wil ik Rhianne, en Danielle, extra bedanken voor hun gezelligheid en vrolijkheid binnen en buiten de werkuren, en de leuke lunches en etentjes.

Naast alle collegiale steun in Nijmegen wil ik ook iedereen bedanken die wat verder van het project af heeft gestaan, maar indirect toch een belangrijke steun is geweest bij de totstandkoming van dit proefschrift en voornamelijk mijn welzijn tijdens mijn PhD. Allereerst mijn familie. Ma, ik ben er zeker van dat het voor jou niet gemakkelijk is geweest om al die jaren zo ver van je oudste dochter te leven. Maar ik ben dankbaar dat je me vrij hebt gelaten om in Nederland te blijven en mijn dromen na te streven. Je hebt me geleerd dat je hard moet werken en nooit moet opgeven om je doelen te bereiken. Ik hoop dat je weet dat ik door jou zo ambitieus ben geworden. Ik dank je voor je onvoorwaardelijke liefde en steun. Marvin, ook al waren we de meeste tijd op afstand van elkaar, ik voelde altijd je steun en liefde. Bedankt voor je grappige berichtjes via whatsapp, maar ook voor de heerlijke maaltijden wanneer we samen waren. Murielle, ik ben je heel dankbaar dat je vaak voor Arya hebt opgepast zodat ik nog even kon doorwerken en voor de gezellige en leuke tijden die we samen hadden toen je nog in Nederland was. Het was fijn om familie zo dichtbij te hebben wonen. Justin, degene die mijn interesse in een PhD heeft aangewakkerd. Bedankt voor je betrokkenheid en dat je altijd zo trots over je kleine zusje sprak tegen anderen. Tante Karin (mijn moeder in Nederland) en oom Theo, ik hoop van harte dat jullie weten hoe groot jullie steun voor mij is geweest de afgelopen jaren. Jullie deur stond altijd voor mij open en jullie waren altijd bereid om naar mijn geklaag te luisteren en probeerden mij altijd te helpen op welke manier dan ook. Daarnaast heeft jullie oprechte belangstelling voor mijn "verslag" mij veel goed gedaan, de bevalling is eindelijk achter de rug en de baby is af!

The real deal (Stacey, Tanisha en Veronique): Esey boso echt ta tambe! Danki pa semper keda push me y pa apoyami te na fin. Misa cu boso ta hanja cu mi ta

loco pa a hasi writing mi job, pero semper boso a laga sa con orguyuso boso ta dimi! Stima boso schatjes! Eva, Annelieke en Mandy, jullie zijn een enorme steun geweest de afgelopen jaren. Bedankt voor alle gezelligheid, feestjes, borrels en spelletjesavonden, maar ook voor het helpen met de kinderen tijdens de lockdowns. Zonder jullie steun zou ik nu nog steeds mijn proefschrift aan het schrijven zijn!

Tot slot, mijn woorden van dankbaarheid en liefde gaan naar mijn gezin. Jerald, het is niet altijd makkelijk voor je geweest en zeker het laatste jaar niet. Maar bedankt voor je hulp en steun toen ik in de weekenden en avonden moest schrijven om mijn proefschrift in deze tijden af te kunnen ronden. Waarschijnlijk was ik op sommige momenten thuis niet altijd even vrolijk en ontspannen. Gelukkig kon je me altijd opvrolijken en me laten beseffen dat ik te ver ben gekomen om nu op te geven. Bedankt ook dat je altijd naar mijn werkverhalen luisterde en deed alsof het je oprecht interesseerde. Arya, mijn mini influencer. Het is mooi om te zien hoe trots je bent op mij en mijn werk, waardoor je zelfs al je vriendinnen verteld hebt dat ze meer water moeten drinken omdat anders je mama ze zou komen onderzoeken. Hierdoor gingen je vriendinnen inderdaad ook meer water drinken, maar waarschijnlijk zijn ze nu ook bang voor mij. Omdat je altijd zo geïnteresseerd bent geweest in mijn boekje door steeds te vragen hoever ik was en me letterlijk aan te moedigen als een cheerleader, heb je ervoor gezorgd dat ik nog energie had om de laatste loodjes af te ronden. Nu kun je eindelijk mama's boekje aan de juf geven zodat ze het kan voorlezen aan al je klasgenoten. Kyan, je bent nog te klein om te begrijpen wat mama de afgelopen jaren heeft gedaan. Maar je glimlach en je grappige streken maakten me altijd aan het lachen, zelfs op de meest gestreste momenten. Hopelijk mag mijn proefschrift later ook voor jou als voorleesboek dienen.

En om deze lange dankwoord, hetgeen uiteraard van mij te verwachten was, te beëindigen, wil ik tot slot nog iets heel belangrijks tegen iedereen zeggen:

BEBE MAS AWA!

—Crystal

ABOUT THE AUTHOR

Crystal Smit was born on December 8, 1988, in Willemstad, Curaçao. In 2012 she received her bachelor's degree in pedagogical sciences at Radboud University Nijmegen, The Netherlands. Following, she started a two-year research master's at the Behavioral Science Institute of the same university. After completing her research master in Behavioral Science in 2014, she started working on her PhD project embedded in the *MyMovez* research program, of which this dissertation is the final product.

Currently, Crystal is working as a Postdoc researcher and lab manager in the *Movez Lab* at the Erasmus School of Social and Behavioural Sciences, Erasmus University Rotterdam, the Netherlands. With her research she focuses on how to optimally motivate young people in campaigns to voluntarily adopt positive health behaviors. For a full scientific curriculum vitae please visit www.crystalsmit.com.